



IMPERIAL INSTITUTE
OF
AGRICULTURAL RESEARCH, PUSA.

MYCÓLOGIA

VOLUME XXII, 1930

MYCOLOGIA

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Volume XXII, 1930

WITH 25 PLATES AND 11 FIGURES

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PUBLISHED BIMONTHLY FOR
THE NEW YORK BOTANICAL GARDEN
By LANCASTER PRESS, INC.
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LANCASTER PRESS, INC.
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MIDDLE BOULDER CAÑON

MYCOLOGIA

VOL. XXII JANUARY-FEBRUARY, 1930 No. 1

A MYCOLOGICAL FORAY THROUGH THE MOUNTAINS OF COLORADO, WYOMING AND SOUTH DAKOTA

FRED J. SEAVER AND PAUL F. SHOPE

(WITH PLATES 1-7)

During the summer of 1929, after an extended correspondence, between the senior author, of The New York Botanical Garden, and the junior author, of the University of Colorado, plans were finally consummated for a joint expedition into the mountains of Colorado and adjacent states in search of fungi. Boulder was made the base of these operations and the authors joined forces there on the 22d of July.

On the following day a temporary sub-base was established in Middle Boulder Cañon at an elevation of 10,000 feet, in the deserted mining settlement of the U. S. Gold Corporation. Selecting one of the least dilapidated cabins of the settlement, the party consisting of the writers and Mr. M. O. Jung, proceeded to make themselves comfortable (PLATE 1). The only furnishings of this shack consisted of a small stove and a pile of straw. Both were appreciated since at this elevation the camp was just below the regions of perpetual snow which still hung in the gulches above, and the temperature at night fell to, or approached, the freezing point. During the daytime, however, it was very comfortable and the weather was favorable for collecting, an unusual condition since daily rains frequently occur at this altitude.

The predominating trees in this region consisted of spruces

[MYCOLOGIA for November-December (21: 301-348) was issued
November 1, 1929]

(*Picea Engelmanni*), limber pine (*Pinus flexilis*) and firs (*Abies lasiocarpa*) and, since the distribution of fungi is governed more by the substratum than by the temperature and altitude, an especial effort was made to collect the forms which occurred on and under these trees. Two of the commonest cup-fungi in the region were *Dasyscypha Agassizii* and *Dasyscypha arida*, both rather conspicuous by reason of their brilliant color. One of the most interesting cup-fungi found here was apparently *Paxina nigrella*, previously known only from a single collection obtained by Dr. L. O. Overholts at Tolland. This was found commonly around the edges of the melting snow drifts and much material was added to our formerly scant collection. The great profusion of spring flowers, especially dog-tooth violets growing in close proximity to the melting snows in July presented, not only a charming spectacle but was of real interest to one not familiar with these conditions. The highest elevation visited here was about 12,000 feet.

After returning to Boulder and caring for the material collected, the base of operations was transferred to the University of Colorado Summer Camp, located at an elevation of 9,600 feet, where the coniferous forests were supplemented by dense growths of aspens (*Populus tremuloides*) (PLATE 3). This camp was in charge of Dr. W. E. McCourt who kindly extended to the writers all the privileges of the camp. Much interest was shown by the science students in the many boletes and agarics which abounded at this time and the writers were frequently questioned as to their edibility. Several pleasant evenings were spent around the large camp-fire in conferences presided over by Dr. McCourt and his corps of able assistants. Here the partially buried cup-fungus, *Sepultaria aurantia*, previously known in this country only from the type locality in Nebraska, was collected in abundance. The color of the interior of the apothecia is pale yellow, becoming decidedly orange as they mature and begin to dry out.

This species was originally described by Dr. F. E. Clements and was listed in The North American Cup-fungi with some misgivings since at that time we had no material and were compelled to rely on the record alone. The material obtained is



MIDDLE BOULDER CAÑON

therefore a most valuable addition to our collection. As intimated in The North American Cup-fungi, this species is probably identical with the earlier European species, *Peziza hybrida*. The recent collections will undoubtedly enable us to prove or disprove this suspicion.

Probably the most important discovery in this region was the perfect stage of the sclerotial disease of the aspen trees. The imperfect stage, *Sclerotium bifrons*, has long been known and is so abundant in this section, that it is a serious menace. Fully twenty-five per cent of the leaves of some of the trees were killed and it seemed to become worse as the season advanced. Dr. T. D. A. Cockerell suggested the name "ink-spot fungus" as an appropriate one for the sclerotial stage of the organism and it seems quite suitable since at this stage the fungus looks like a blot of ink.

While the sclerotial stage of the fungus has been known since 1890 and collected frequently in the Rocky Mountain states, so far as the writers were aware the perfect stage had never before been observed. Knowing that this should be a stipitate cup-fungus of the *Sclerotinia* type, special search was made for it. Persistence finally won and in a moist ravine near the University of Colorado Summer Camp the ascigerous stage was obtained in abundance. This occurred where the leaves had matted together and were kept constantly moist. Apparently the apothecia develop only after the leaves have lain for several seasons. Often the sclerotia fall out but more frequently they fall with the leaves and remain after the leaf has entirely decayed. Since this discovery was made, Professor H. H. Whetzel of Cornell University, who has made a careful study of this genus, reports having seen apothecia, of the fungus *Sclerotinia bifrons*, near Ithaca but, so far as can be discovered, these observations have not yet been published.

Each sclerotium produces from three to six or eight stipitate apothecia, the length of the stem varying with the conditions. The apothecia are about 1-1.5 mm. in diameter and the stem up to 4 mm. in length (PLATE 4). The whole ascophore is whitish or slightly yellowish. When mature, they puff profusely. Whether infection takes place directly from the germinating

ascospores has not been determined but since the sclerotia and apothecia occur at about the same time, it is likely that it does. A detailed study of the life-history of the fungus would furnish an excellent problem for some local research student.

Returning to Boulder on July 31, the party started the next morning for Laramie, Wyoming to attend the summer meeting of the western branch of the Botanical Society of America which was to be held at the University of Wyoming Summer Camp. Visiting botanists were lodged the first night in the luxurious quarters of the men's dormitory of the University. A banquet was held during the evening at which Dr. T. D. A. Cockerell was the chief speaker, and the next morning the entire delegation started for the summer camp, located at an elevation of 9,600 in the mountains of the Medicine Bow Range, and about forty miles distant from the University.

The mycological section was ably presided over by Professor Joseph C. Gilman of the State College at Ames, Iowa. The pathologists united with the mycologists since their interests were for the most part in common with them. The special interests of the collectors were diverse, the authors being concerned with the cup-fungi and the woody fungi while Professor A. O. Garret of Utah was rather expert in the collection of the rusts and smuts and quite familiar with the hosts in this region; the interests of other members of the section were more general. Consequently a large collection of rusts was made and will be eventually divided among the various collectors present. The work of the mycological section consisted largely of excursions into the field, supplemented by brief conferences in camp (PLATE 5) in which the collections of the day were reviewed.

The entire delegation of botanists joined in some of the expeditions under the guidance of Professor Aven Nelson. On one occasion cars were driven to Brooklyn Lake, a beautiful body of water located at an elevation of about 10,500 feet and constantly fed from the melting snow pocketed in the gulches on all sides. The party completely encircled the lake gathering many rare sub-alpine flowering plants while the mycologists collected a number of interesting fungi including parasites on these plants.



NEAR UNIVERSITY OF COLORADO SUMMER CAMP

During the last day of the meeting, a trip was made to the summit of Medicine Bow Range. Cars were driven as far as road conditions permitted and the latter part of the trip was made by some of the sturdy members of the party who had a likeness for climbing. Others botanized about the numerous mountain lakes of this region. One object of interest was the red snow caused by the alga, *Sphaerella nivalis*. The meeting closed on Sunday and the writers returned to their base at Boulder.

This first summer meeting of the Botanical Society was a decided success and the members present were unanimous in requesting that they be continued. Whether the meetings should be held in the same place each year or whether they should be rotated were matters which only the central organization can decide. The University of Wyoming Summer Camp is an ideal place for meetings such as this and the University extended a most cordial invitation to come again, if the society should see fit to do so.

After the return drive of 180 miles on August 4, the writers started early the next morning on a previously arranged excursion to the Black Hills of South Dakota at the invitation of Professor Junius Henderson who was especially interested in securing cycads from the Cycad National Monument. In spite of the fact that the drive was across the semi-arid plains of Colorado and Wyoming, a number of parasitic fungi were collected along the way. Camp was made the first night at Torrington, Wyoming and a few specimens collected at that place. The journey was resumed next morning as far as Edgemont, South Dakota where it was interrupted by a heavy rain said to be the first in this section for several months. The trip was continued the next morning as soon as the roads became passable and after a brief stop at Wind Cave tents were pitched at Legion Camp, elevation 6,500, amid a forest of mixed pines (PLATE 7).

Conditions in these pine forests were exceedingly favorable for collecting fungi especially because of the almost daily showers. The forest floor yielded an abundant crop of agarics and boletes. While stationed here, a drive was made through the Needles of South Dakota to Sylvan Lake and a number of fungi collected.

The work, however, was interrupted by rain. The following day, August 9, camp was broken and the return drive begun, stopping at intervals between Legion Camp and Wind Cave to collect. On one of these brief pauses, an unusually fine collection of *Hypomyces Lactifluorum* was secured. This fungus is a parasite on some species of *Lactaria* and so obliterates the gills that the specific identity of the host is determined with difficulty, if at all. The whole parasitized plant is unusually conspicuous since it assumes a brilliant orange red color which turns to purple as the host decays. After visiting the Cycad National Monument, camp was made for the night at Hot Springs, South Dakota. On August 10, the return was continued and after camping again at Torrington, the party arrived in Boulder on the afternoon of August 11.

After spending two days in caring for materials and exploring some of the nearby canons, an expedition was planned to Pikes Peak primarily in order to visit the Alpine Laboratory of the Carnegie Institution which is under the direction of Dr. F. E. Clements. Numerous stops were made and some very rich collecting grounds encountered between Sedalia and Colorado Springs by way of the foothills road which has been recently constructed. From Manitou the ascent was made, by means of the cog road, to Minnehaha, the site of the Alpine Laboratory, elevation 8,300 feet. Two very pleasant and profitable days were spent here and the writers were accompanied on one of these by Dr. and Mrs. Clements whose familiarity with the surroundings made it possible to obtain a large collection of cup-fungi and much data was acquired which will be of use in future work. The return to Boulder was made on August 16.

The senior writer after a few days in Denver returned to Boulder and spent an enjoyable evening with Dr. Elam Bartholomew so well known as distributor of Fungi Columbiani, as well as for other valuable mycological contributions. While Dr. Bartholomew was spending a few days in Boulder*visiting his daughter, he and the junior author made a one day collecting trip to Tolland.

* A short stay was next planned in Coal Creek Cañon at "El Joya del Monte," elevation 7,500 feet, the mountain home of



SCLEROTINIA BIFRONS

Mr. A. G. Seaver, brother of the senior writer. While here a drive was planned to the mouth of the Moffatt Tunnel, just above Tolland at an elevation of 9,000 feet, and a number of collections made.

Returning to Boulder on August 27, the last long expedition of the summer was arranged to Grand Lake. This is the largest lake in Colorado and one of the few lakes of its size to be found at this high altitude, 9,000 feet. The writers made the drive from Boulder to Grand Lake between 8:00 P.M. and midnight by way of Fall River Pass which ascends to an elevation of about 12,000 feet and well above timber line. The two days spent at the lake yielded good results.

After spending a few days in Boulder packing and shipping materials, the senior writer returned to Denver and started on September 7, for the East, while the junior author, accompanied by Mr. M. O. Jung, proceeded to the western slope and collected in the Ohio Creek region, near Gunnison; thence to Grand Mesa where collections were made over a period of eight days. Nearly six hundred collections of fungi were taken including many valuable cup-fungi, one of the chief objects of quest, and which will be of vast importance in working up a second volume of the North American Cup-fungi which is now in course of preparation. Sufficient material was obtained so that many duplicates can be made for exchange, especially with foreign countries, and thus add still more to our already large collection of this group of fungi and, at the same time, help to correlate European and American forms.

In general the summer of 1929 was a poor one for collecting fungi. The early summer was cold and extremely dry which no doubt exercised some influence on the fungi in general. After the first week in July, daily summer showers occurred. The junior author records the summer's collections of polypores as the poorest in the past five years. The Grand Mesa region was, however, better watered than the mountainous region farther east. Good collections of polypores and other fungi were made here.

The writers wish to express their hearty thanks to Professors Ramaley, Junius Henderson, and T. D. A. Cockerell of the

University of Colorado; also Dr. W. E. McCourt and members of the Staff of the University of Colorado Summer Camp; to President A. G. Crane, Professor Aven Nelson and members of the staff of the University of Wyoming; and to Dr. and Mrs. F. E. Clements of the Alpine Laboratory for their hospitality and cooperation in the prosecution of this work.

THE NEW YORK BOTANICAL GARDEN
UNIVERSITY OF COLORADO

EXPLANATION OF PLATES

All photographs accompanying this article were made by the junior author.

PLATE 1. Camp site in Middle Boulder Canon, elevation about 10,000 feet. The cabin in the lower left-hand corner was occupied by the authors of this article July 23-26, 1929.

PLATE 2. Middle Boulder Canon, showing Arapahoe Peak (upper figure) and Diamond Lake (lower figure). The Lake is located about 1,000 feet above the camp site shown in PLATE 1.

PLATE 3. Aspen grove and mycological base near University of Colorado Summer Camp, where the perfect stage of the ink-spot fungus was collected.

PLATE 4. *Sclerotinia bifrons*. Near the center a branch of an aspen, slightly reduced, showing healthy leaves and those infested with the ink-spot fungus (*Sclerotium bifrons*). Note the zonate markings of the infected leaves. At the right three clusters of apothecia growing from the old sclerotia and enlarged about five times. At the left drawing of an ascus and the spores, much enlarged.

PLATE 5. University of Wyoming Summer Camp in the Medicine Bow Mountains, elevation 9,600 feet, showing the newly erected assembly room in which the meetings of the Botanical Society of America were held the summer of 1929.

PLATE 6. Drive through the Needles of South Dakota showing the spire-like formation of the rocks.

PLATE 7. Mycological base in the Black Hills of South Dakota located in Legion Camp, elevation 6,500 feet, and forests of mixed pines.



UNIVERSITY OF WYOMING SUMMER CAMP



NEEDLES OF SOUTH DAKOTA



BLACK HILLS OF SOUTH DAKOTA

BREEDING ALBINISTIC STRAINS OF THE MONILIA BREAD MOLD

B. O. DODGE

(WITH PLATES 8 AND 9 AND 1 TEXT FIGURE)

INTRODUCTION

Mutations are frequently reported as appearing in laboratory cultures of *Aspergillus*, *Alternaria* and other species of the imperfect fungi. In some instances certain stimuli or environmental conditions are conducive to variation, yet no one has explained why these particular fungi are so prone to mutate. Clearly if the cause of the sudden alteration in growth forms is some change in the chromosome complex, it must have been effected in nuclei long since haploid. The custom of propagating the mutants asexually does not serve to tell us very definitely whether it is the cytoplasm, the nuclei as a whole, or the individual chromosomes which are the units involved. Harder (9) has experimented with mycelia of certain Hymenomycetes and proved that in some instances the cytoplasm itself is effective in determining the type of mycelial growth. The situation is one which serves to emphasize the need of knowing the full life history of the mutating fungus so that it can be cultured and reproduced sexually. Nuclear fusions and reduction divisions provide the opportunity for bringing together and redistributing factors of inheritance. If any such elements are involved in the origin of an *Aspergillus* mutant, for example, a series of cultures from single ascospores obtained by propagating the mutant sexually ought to reveal the fact.

A bisexual mycelium of *Neurospora tetrasperma* frequently forms a unisexual conidium (5). The mycelium developed from this conidium will never produce ascocarps. The mycelia from normal conidia of the parent mycelium do so readily. The change is simply due to the unequal distribution of nuclei in the hyphal branches forming the conidia. Normal conidia receive two kinds of nuclei, the abnormal only one kind, as

regards their sex. The sex of each nucleus is determined in the reduction divisions in the ascus. No change of sex occurs in somatic divisions. Suppose the unequal distribution of nuclei had taken place soon after the bisexual germinating ascospore had been planted at the center of a plate culture; a whole sector of the mycelium as it grew out would have been unisexual. Transfers from this sector would be quite unlike the parent form culturally and sexually. This is a sort of mutation easily explained only because something is known of nuclear behavior (3)

The albinistic strains of *Monilia sitophila* reported recently (6, 7) could perhaps be regarded as true mutations. Their chief interest, however, lies in the fact that their failure to produce conidia in the fashion characteristic of the species seems to be due to certain inherited factors which regularly segregate in the reduction divisions. An analysis of the mycelia from which the sterile albinistic strains were developed by sexual reproduction suggests that somatic changes may have been instrumental originally in bringing about conditions which were first made manifest when ascospores from the mating were germinated.

Formerly in breeding work involving animals and higher plants one was not much concerned as to just where in the divisions of the mother-cell segregations of the factors of inheritance occurred. Dealing with the progeny of large numbers of mother-cells in mass or as populations it really made little difference. The fungi, particularly the heterothallic ascomycetes and basidiomycetes are now being studied more and more from the standpoint of genetics. The peculiarities of the ascus, the promycelium, and the basidium are such that the products of the reduction divisions of individual mother-cells can be singled out and mated together or inbred in a way absolutely precluded in a case of higher plants and animals. This gives to the question of certain details of segregation an added interest.

In the course of a study on giant ascospores (6) it was found that in a normal ascus of *Neurospora crassa* the eight spores alternate four and four as to their sex, instead of two and two as had been previously reported (4) for *N. sitophila*. It was pointed out (7), however, that in certain strains of the latter

species also the sex factors are frequently segregated in the first division so that the spores alternate four and four in the ascus as to their sex. The culture experiments which furnished the evidence for these conclusions, and the methods by which albinistic strains were obtained will now be described in more detail.

ARLINGTON STRAINS OF *NEUROSPORA SITOPHILA*

Among the "Arlington" strains of *Neurospora sitophila* cultured by Shear and Dodge (13) were two strains which were kept as stock cultures by the writer because they always produce perithecia abundantly when grown together. They are readily distinguished from each other by the color of their conidial masses. "Arl.6," which is a haplont A, produces the salmon pink or light orange colored conidia. "Arl.10" is a haplont B. It is somewhat lighter in color perhaps because it usually develops fewer conidia. It produces more of the dark colored bodies which have been referred to as sclerotia or bulbils. Both strains are presumed to have been derived from single ascospores originally; each has since been transferred many times. The two Arlington strains or clons are the ones cultured to obtain the results reported. Their peculiarities, particularly those of Arl.10, will be described more fully later in this paper.

METHODS OF CULTURE

The culture methods employed have been fully described (4, 13). Heretofore it had been observed that ascospores of this species rarely germinate at room temperatures. The discovery that several spores which had been isolated from one ascus had germinated in the interval during which they had been set aside to allow conidia to germinate before the ascospores were heated, suggested a change in the procedure. Taking greater precautions to exclude conidia, the ascospores that germinate without heating are first transferred, and then the remainder are stimulated to grow by heating them. It is only by chance even then that one gets all eight spores from an ascus to grow.

ALBINISTIC RACES OF *NEUROSPORA SITOPHILA*

Ascus no. 56 was the first one from which cultures were obtained from all of its spores. This set of eight cultures has been referred to briefly in another connection (6, p. 230). The spores had been isolated one by one so that the position which each had occupied in the ascus was known with certainty. The germinating spores were first transferred to agar in petri dishes. Spores nos. 1, 2, 3 and 4 were put in one plate and nos. 5, 6, 7 and 8 in another. The germ tubes were allowed to grow and branch until it was possible to obtain two sets of tube cultures by transferring tip ends of young hyphae. The ascospores themselves were not transferred. Each plate culture therefore still contained four young haplonts derived from four ascospores from the one or the other end of the ascus. If no perithecia developed in either culture it would be positive proof that all four spores in one end of the ascus were alike as to sex. If perithecia did finally develop, nothing would be proved except that in some way two sexually different spores had been introduced into the same culture. The tube cultures were numbered consecutively 1 to 8 to indicate the original positions of the spores in the ascus. They were then placed in a tube rack in the same order. This little detail was probably the one thing that brought out the very striking differences which the cultures showed after they had been incubated at 27° C. for two days. Cultures nos. 1, 2 and 5, 6 had already developed an excessive growth of whitish aerial hyphae, but no conidia, while cultures nos. 3, 4 and 7, 8 showed that many salmon-pink conidia were being formed. This was interpreted to indicate an alternation in pairs as to sex as described by Wilcox (14). The parent strains Arl.6 and Arl.10, it will be remembered, are readily distinguished from each other by the color and extent of their conidial masses.

Assuming that haplonts nos. 1, 2 and 5, 6 would eventually develop conidia, the cultures were again incubated for two more days. At the end of this time the differences previously noted appeared to be even more marked. Four of the cultures still showed no conidia. The illustration, PLATE 8, was reproduced from a hand colored photograph of this set made when the

cultures were four days old. A third set of 8 cultures was made a few days later. After many months the three sets of cultures still present a very striking picture of an alternation in pairs as regards production of orange-colored conidia. The aerial hyphae of mycelia nos. 1, 2 and 5, 6 produce few if any conidia. Without knowing their history it is a question whether one would recognize these mycelia as belonging to a species of *Monilia*, much less to *Monilia sitophila*. There is sometimes a tendency to form constrictions along the tip ends of the aerial hyphae, but, if any, there are certainly very few real conidia dislodged. The method of branching as the hyphae grow against the side of the test tube is suggestive, perhaps, of a *Monilia*. Under certain conditions the tufts or mats of aerial hyphae formed at the top of the agar slant have a pale yellowish color, but, in general, they are only faintly tinted. These strains will be referred to as albinistic for convenience, although, as noted previously, their real interest lies more in the fact that they are practically sterile as regards production of conidia.¹ On the other hand they have provided in their sclerotia or bulbils, a very efficient means of asexual reproduction. The great quantities of the dark colored bodies is one characteristic of the strains. This would enable one familiar with this peculiarity of species of *Neurospora* to recognize the mycelia as belonging to that genus.

The element of pink which appears even in old cultures of the parent strains Arl.6 and Arl.10 is not evident in old cultures of haplonts nos. 3, 4 and 7, 8 from ascus no. 56. Their masses of conidia are golden in color. Such strains of the fungus may well have served L  veill   as a type for his *Oidium aurantiacum* or Kitasima for his *Monilia aurea* (13). These conidial strains or clons also produce many little sclerotia, but they are not dark colored at first. Later on as the culture begins to dry down the sclerotia darken and they then look much like the bodies produced in cultures of the albinistic clons. The first necessity of the species is the production of conidia to spread the fungus far and wide. When an abundance of these reproductive structures

¹ To avoid digression, and confusion of the main issue at this point, a discussion of the differences between monilioid conidia, *Oidium*-like fragments of hyphae and true microconidia will be taken up in a later paragraph on microconidia.

has been provided then sclerotia are formed to maintain it over unfavorable periods. The albinistic strains develop sclerotia at once.

It has been shown (14) that the spindles of the first and second nuclear divisions in the ascus of *Neurospora sitophila* are placed longitudinally. No evidence has been found to suggest that there is any material change in the location of the four nuclei resulting from the second division. They lie far apart in a row on the long axis of the ascus, and separated from each other by a vacuolate cytoplasm. Since the spindles of the third division are transverse there is necessarily a slight readjustment of the spores after they are cut out to bring them into line. Spores nos. 1 and 2 of ascus no. 56 must have contained sister nuclei resulting from the third division. They would possess the same sets of factors of inheritance whether segregation occurs in the first or in the second nuclear division in the ascus. It is the same with the spores of the pairs 3 and 4, 5 and 6, 7 and 8. If the visible differences exhibited by the alternating pairs of haplonts were due to factors of inheritance which are regularly segregated, and not to some fortuitous set of environmental conditions prevailing at the time, segregation of these factors must have occurred in the second division in the ascus and not in the first, otherwise the ascospores would have alternated four and four as regards the production of conidia.

Neurospora sitophila has been proved to be heterothallic. There are only two sexes, and a particular mycelium will be of one or the other of these two sexes. This is not saying that certain pairs of strains are not more fertile or compatible than other pairs when grown together. In fact this is one of the notable things observed in culturing the species as will be pointed out later. Occasionally a single ascospore culture will develop a few large bodies resembling perithecia (13). Many of these structures in old cultures have been examined but as yet no ascospores have been found in them. It is evident that a haploid mycelium can occasionally develop the framework of a perithecium without being paired with a mycelium of the opposite sex. It is possible that by special treatment these bodies could be induced to develop further and even produce spores. From

a genetic standpoint this would be of the greatest interest. Obviously any abnormal ascospore which acquired by accident two nuclei of opposite sex at its delimitation would give rise to a homothallic mycelium which would of itself be capable of producing perithecia. No doubt further study of giant ascospores will result in the discovery of just such strains. To determine the sex of 8 haplonts derived from a particular ascus it is only necessary to grow each one in a culture with the same "tester" strain. In order that there could be no question on this point the custom of growing the haplonts in pairs in all possible combinations was adhered to. Duplicates were not always made however.

The 8 haplonts derived from ascus no. 56 were grown in pairs in all possible combinations. It may be well to consider in advance what this would involve. First, there would be six combination cultures in which two albinistic strains would be grown together. Second, there would be sixteen cultures in which one albinistic strain would be grown with a strain which produces typical orange-colored conidia. Third, there would be six other combination cultures, both strains of which produce conidia. Furthermore if the factors for sex and the factors for conidia, were segregated at the same time, namely in the second division, then the only cultures which would develop perithecia would be the sixteen containing one albinistic and one conidial strain.

Should, however, the factors for sex be segregated in the first division so that the spores alternate four and four in the ascus as regards their sex, it is clear that one pair of albinistic haplonts, nos. 1 and 2 would be of one sex and the other pair, nos. 5 and 6, would be of the opposite sex; conidial strains nos. 3 and 4 would be of opposite sex to that of conidial strains nos. 7 and 8. Perithecia could be expected in sixteen cultures. Four of these cultures would each contain a pair of albinistic strains of opposite sex; four cultures would each contain a pair of conidial strains of opposite sex; eight cultures would contain one albinistic and one conidial strain of opposite sex. The possibility of developing new races which could be propagated indefinitely sexually depended on where the sex factors separated.

The results of the matings are shown in TABLE I and prove conclusively that the two sets of factors had segregated independently.

TABLE I

RESULTS OBTAINED BY GROWING IN ALL POSSIBLE COMBINATIONS THE EIGHT HAPLONTS DERIVED FROM ASCUS No. 56 OF
Neurospora sitophila

Haplonts are numbered in the order in which the ascospores were disposed in the ascus. The sign + indicates that perithecia were formed. The sign - indicates that no perithecia were produced.

	1	2	3	4	5	6	7	8
1	-	-	-	-	+	+	+	+
2	-	-	-	-	+	+	+	+
3	-	-	-	-	+	+	+	+
4	-	-	-	-	+	+	+	+
5	+	+	+	+	-	-	-	-
6	+	+	+	+	-	-	-	-
7	+	+	+	+	-	-	-	-
8	+	+	+	+	-	-	-	-

The table shows that haplonts nos. 1, 2, 3 and 4 were all of one sex, and haplonts nos. 5, 6, 7 and 8 were of the opposite sex. This means that the sex factors had separated in the first division. Four cultures, 56(1 + 5), 56(1 + 6), 56(2 + 5) and 56(2 + 6), each containing two albinistic mycelia, produced perithecia very quickly and abundantly. The eight cultures containing one albinistic and one conidial strain each, and which produced perithecia, were the following: 56(1 + 7), 56(1 + 8), 56(2 + 7), 56(2 + 8), 56(3 + 5), 56(3 + 6), 56(4 + 5), and 56(4 + 6). Four cultures, 56(3 + 7), 56(3 + 8), 56(4 + 7) and 56(4 + 8), containing two conidial strains, also produced perithecia.

Since it is not known whether the two sexes referred to are differentiated as male and female, we shall for convenience continue to call one sex A and the other sex B (13). All unisexual mycelia of one species which have the sex A are haplonts A. Mycelia having the opposite sex are haplonts B. In the diagrams

(FIG. 1) ascospores which have the sex A are uncolored, and those having sex B are colored black. A spore which carries the factors for conidia is dotted either black or white depending on the color of the background. The four kinds of spores contained in an ascus of the general type of ascus no. 56 are represented diagrammatically in FIG. 1, C.

ALBINISTIC RACES MATED

Whether or not the mycelia would breed true to type could only be told by growing ascospores produced in perithecia from the various matings. It was evident that cultures containing certain pairs of albinistic mycelia were developing perithecia. Would the ascospores of the next generation produce albinistic strains in turn? Due to the fact that the cultures were being incubated at 27°, the mycelia grew rapidly. Perithecia began to appear first in culture 56(2 + 6) on the third day. At the end of 11 days mature ascospores were being discharged. One ascus designated as 56(2 + 6)a to indicate its parentage, was selected. The 8 spores were isolated one by one in order and germinated. The mycelia thus obtained were numbered consecutively 1 to 8 to correspond to the order in which the spores had been disposed in the ascus. The haplonts were then grown together in pairs in all possible combinations and in duplicate. The results of the matings are shown in TABLE II.

Haplonts nos. 1, 2 and 5, 6 were found, as indicated in the table, to be of the same sex, and haplonts nos. 3, 4 and 7, 8 were also alike sexually but of the opposite sex. The spores thus alternate in pairs, so that segregation of the sex factors in this case must have occurred in the second nuclear division. Such an ascus is diagramed in FIG. 1, D.

These cultures show that the albinistic character possessed by the parent strains nos. 2 and 6 from ascus no. 56 has been retained in the offspring. That this is a rather fixed character has been further demonstrated by germinating many ascospores of the new generation. Spores from culture 56(2 + 6) were sowed on the surface of agar in petri dishes. Fifteen different mycelia were obtained from single ascospores which happened to germinate without heating. These haplonts were all albinistic. The

spores of the original sowing which did not germinate were then heated moderately, and many more were thus stimulated to grow. Ten germinating spores were selected at random. Their

TABLE II

RESULTS OBTAINED BY GROWING IN ALL POSSIBLE COMBINATIONS THE
EIGHT ALBINISTIC HAPLONTS DERIVED FROM ASCUS
No. 56(2 + 6)a

The haplonts are numbered in the order in which the ascospores were disposed in the ascus.

	1	2	3	4	5	6	7	8
1	-	-	+	+	-	-	+	+
2	-	-	+	+	-	-	+	+
3	+	+	-	-	+	+	-	-
4	+	+	-	-	+	+	-	-
5	-	-	+	+	-	-	+	+
6	-	-	+	+	-	-	+	+
7	+	+	-	-	+	+	-	-
8	+	+	-	-	+	+	-	-

mycelia were also all albinistic. Other ascospores were subjected to a very much higher temperature, well toward the maximum, evidently, for only a few spores germinated as a result. Thirteen haplonts were selected. Again all proved to be albinistic. Tufts of their mycelia were shaken in sterile water and plates were poured in the ordinary way. When three loops of the water were included only one colony was developed. This had originated from a fragment of mycelium and not from a conidium. Another plate which contained three loops of a suspension from the conidial strains 56.8 developed a great many colonies. Albinistic mycelia have been grown on hard corn meal agar, dextrose agar, potato dextrose agar, sterilized bread in flasks, on loaves of bread under bell jars and on potato plugs. In some cases the mycelium possesses more of the pink coloration than it shows on corn meal agar. If conidia were produced they were not noticeable. No evidence has been obtained to show that the kind of medium makes any material difference.

It is scarcely to be expected that the albinistic strains are absolutely sterile. Conditions may be found under which some monilioid conidia will be formed normally.

MATING TWO CONIDIAL STRAINS FROM ASCUS NO. 56

When, for example, strain 56.4 is paired in culture with strain 56.8, there will be two conidial strains of opposite sex growing together. Each strain produces its own conidia and naturally such a culture will show an abundance of conidia. In order to learn whether ascospores from this kind of culture would be arranged in the ascus, two and two or four and four as to their sex, spores from one ascus designated 56(4 + 8)a, to indicate its origin, were isolated. Only five spores germinated. These were nos. 1, 3 and 4 from one end of the ascus, and nos. 5 and 7 from the other end. Tube cultures were obtained in the usual way, after which the haplonts were grown together in pairs in all possible combinations. The results were conclusive in spite of the fact that three of the eight haplonts were missing. All of the mycelia produced conidia. Haplont 1 was proved to be of opposite sex to that of haplonts 3 and 4. Haplonts 5 and 7 when grown together developed perithecia, showing that they were of opposite sex. Again segregation of the sex factors had occurred in the second division, for the spores alternated in pairs as to their sex (FIG. 1, *E*). A checkerboard diagram to show the results of these matings would be of the same type as that shown in TABLE II.

After culture 56(4 + 8) had matured sufficiently so that a spore print had been formed on the side of the tube, sowings of ascospores were made in the manner described in connection with culture 56(2 + 6). Thirty single ascospore mycelia were obtained. All of the cultures showed the same great abundance of golden colored conidia. Certainly the segregations that had occurred in the two generations had in some way served to purify these conidial strains. Their conidia show the pink coloration only in young cultures. When strain no. 7, for example, is grown on a loaf of bread under a bell jar and strain no. 2 from ascus no. 56 is grown under similar conditions, the pictures presented suggest two entirely different species of mold.

The results of the experiments which have been described indicate that ascospores obtained by mating two albinistic races in turn develop albinistic mycelia. When two conidial strains are mated the mycelia from their offspring ascospores will produce conidia prolifically. In other words, these strains breed true for conidia as far as they have been tested out.

MATING AN ALBINISTIC RACE WITH A CONIDIAL RACE

It remains to learn what will be the results when an albinistic strain is crossed with a strain which bears conidia normally. Culture 56(2 + 7) was selected for this experiment. Haplont no. 2 from ascus no 56 is albinistic; no. 7 from the same ascus bears conidia. The ascus designated as 56(2 + 7)a was isolated from a perithecium of the culture. The 8 spores were carefully separated and germinated. The tube cultures obtained were numbered consecutively 1 to 8 to show the order of the spores in the ascus. After having been incubated for two days it was evident that segregation of the factors for conidia had again occurred in the second nuclear division in the ascus. Four of the spores, nos. 3, 4 and 7, 8 had developed albinistic mycelia, and four spores, nos 1, 2 and 5, 6 had developed mycelia which were already cutting off conidia. The eight mycelia were grown together in pairs in all possible combinations. The results were again conclusive. Four genotypically different kinds of spores had been obtained from a single mother-cell. Spores nos. 1, 2, 3 and 4 proved to be all alike sexually and were of sex B. Spores nos. 5, 6, 7 and 8 were of sex A. Sex factors had been segregated in the first nuclear division in the ascus and the factors for conidia had separated in the second division as was the case with ascus no. 56 (FIG. 1, C).

If segregations are always regular, as shown in ascus 56(2 + 7)a when albinistic and conidial strains are mated, every ascus should produce four albinistic and four conidial ascospores, and random selections of ascospores from a spore print should give about equal numbers of the two kinds. Of 77 haplonts obtained from single spores, 49 developed conidia and only 28 were albinistic. In the four different sets of cultures made at various times the results were: 11 conidial, 22 albinistic; 16 conidial, 1 albinistic;

12 conidial, 1 albinistic; 10 conidial, 4 albinistic. Experience has shown that if one selects only the germinating spores at random the results are apt to vary widely from the expectancy. In case of one back-cross mating (4, p. 10) 11 small germinating ascospores were transferred. The haplonts thus obtained were all of sex A. The same experiment was repeated and of the 28 mycelia isolated 20 were of sex A and 8 were of sex B. Further work should be done before reaching the conclusion that the mating of albinistic and conidial strains always results in segregations of the type shown by asci nos. 56 and 56(2 + 7)a.

OTHER ASCI FROM CULTURE ARL.6 + ARL.10

The deduction naturally to be made on the basis of the results of the four experiments with individual asci would be that when "pure line" strains of opposite sex are mated, there being no segregation of factors for conidia, the sex factors are regularly segregated in the second division in the ascus. Further, when albinistic strains are crossed with conidial strains the sex factors are segregated in the first division and the conidial factors in the second. This does not explain how it happened that in mating strains Arl.6 and Arl.10 there should have occurred the very definite segregation of conidial factors as shown by ascus no. 56, because both parent mycelia produce conidia. Although no. 56 was the first ascus from which all eight spores had been isolated in order and germinated, a sufficient number of spores from five asci, nos. 44, 45, 46, 48, and 50 had been germinated to show, when examined later, that segregation of conidial factors had occurred. From one to three of the haplonts obtained from each ascus were albinistic. The fact that these haplonts were not producing conidia was not observed at the time the cultures were first obtained. The spore numbers were too small to be of value to determine how the two sets of factors had been segregated except in case of ascus 46. In this ascus the sex factors had clearly been separated in the first division and the conidial factors in the second division. In order to obtain further evidence regarding the nature of asci produced in cultures of Arl.6 + Arl.10 several asci were isolated from perithecia selected from a new culture. At least six spores from

each of eight asci germinated. The characteristics of the haplonts from each ascus and the type of segregation will now be described briefly.

All eight spores from ascus no. 57 germinated but none of their mycelia, however, proved to be albinistic. They were all forming conidia very rapidly by the third day. The eight haplonts were grown together in pairs in all possible combinations to determine the sex of each one with certainty. The results showed that, as was the case with ascus no. 56(4 + 8)a where all of the haplonts produced conidia, segregation of the sex factors had occurred in the second division, so that the spores had alternated two and two as to sex (FIG. 1, E). Ascus no. 62 proved to be of the same type as ascus no. 57. The eight mycelia derived from ascus no. 58 also produced conidia. In this case it was proved that the sex factors had separated in the first division. The four spores from each end of the ascus were all alike as to sex. Ascus no. 60 was of the same type as no. 58 (FIG. 1, B).

Ascus no. 61 showed an entirely new type. The 8 spores had been carefully isolated and numbered consecutively 1 to 8. Mycelia nos. 1, 2, 3 and 4 were albinistic and mycelia nos. 5, 6, 7 and 8 produced the golden colored masses of conidia. By growing the haplonts in pairs in all combinations it was found that nos. 1, 2 and 5, 6 were of sex A and nos. 3, 4 and 7, 8 were of sex B. The spores had alternated in the ascus four and four for conidial factors and two and two as to sex (FIG. 1, A). Conidial factors had separated in the first division and sex factors in the second. Asci nos. 63 and 65 were like ascus no. 61 in this respect, but ascus no. 64 was like ascus no. 56 where the spores had alternated two albinistic and two conidial, and four of one sex and four of the opposite sex. A summary of the results of all the experiments where five or more haplonts were obtained from an ascus is given in TABLE III. The sex of each haplont, determined by mating it with a tester strain, is designated as A, or B. If a haplont produces conidia this fact is denoted by the sign +. The sign - signifies that the haplont is albinistic.

Six of the 14 asci reported on in detail in the table show segregation of the sex factors in the first nuclear division, while

TABLE III

SEGREGATION OF FACTORS FOR SEX AND FOR CONIDIA IN FOURTEEN ASCI OF *Neurospora sitophila*.
PERITHECIA FROM CULTURES OF THE MATING ARL.6 + ARL.10

First half (S) of each double column shows the sex, A or B, of the particular haplonts which were obtained by germinating spores from that ascus. The second half (C) of each double column shows the production (+) or failure (-) of production of conidia by individual haplonts.

Ascus No.	46		56		56 (2+6) a		56 (2+6) b		56 (2+7) a		56 (4+8) a		57 ²		58		60 ²		61		62 ²		63		64		65	
Spore No.	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C
1	A	+	B	-	B	-	B	-	B	+	A	+	A	+	B	+	A	+	A	-	B	+	A	-	B	-	B	-
2			B	-	B	-	B	-	B	+			A	+	B	+	A	+	A	-	B	+	A	-	B	-	B	-
3	A	-	B	+	A	-	A	-	B	-	B	+	B	+	B	+	A	+	B	-	A	+	B	-	A	-	A	-
4	A	-	B	+	A	-	A	-	B	-	B	+	B	+	B	+	A	+	B	-	A	+	B	-	A	-	A	-
5	B	+	A	-	B	-	B	-	A	+	A	+	A	+	A	+	B	+	A	+	B	+			B	+	B	+
6			A	-	B	-			A	+			A	+	A	+	B	+	A	+	B	+			B	-	B	+
7	B	-	A	+	A	-	A	-	A	-			B	+	A	+			B	+	A	+	B	+	B	+		
8	B	-	A	+	A	-	A	-	A	-	B	+	B	+	A	+			B	+	A	+	B	+	B	+	A	+

² The exact order was not determined except that it was known from which half of the ascus each spore was taken.

these factors had separated in the second division in 8 asci. Segregation of conidial factors had occurred in the first nuclear division in three asci, and in the second division in four asci.

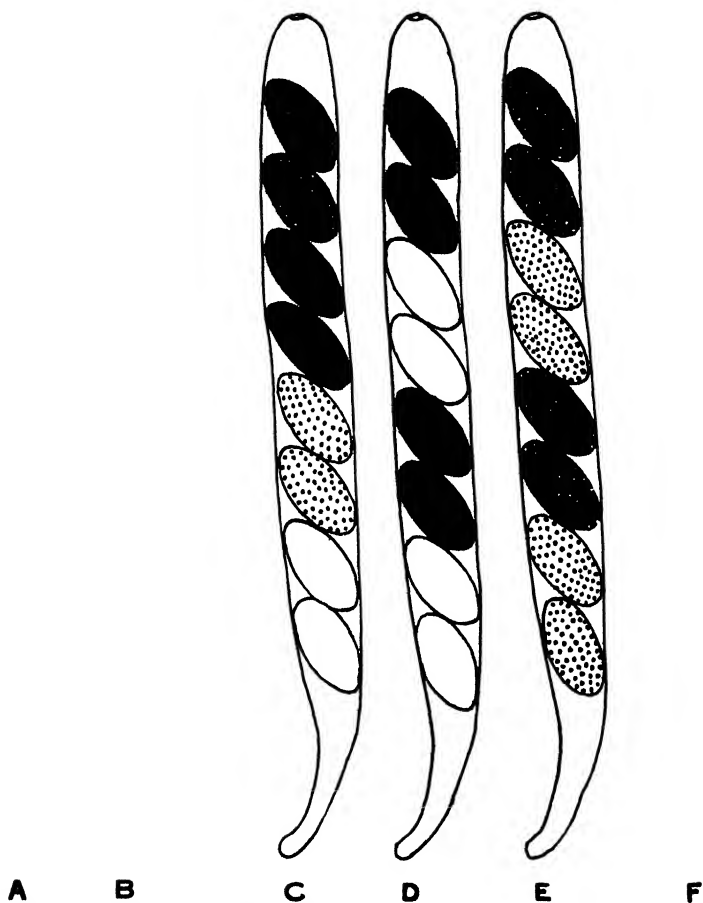


FIG. 1. Diagrams of asci showing that factors for sex and for conidia segregate independently in either the first or the second nuclear division. A-E. *Neurospora sitophila*. A. Ascus no. 61; B. Ascus no. 58; C. Ascus no. 56(2 + 7) a, same general type as no. 56; D. Ascus no. 56(2 + 6)a; E. Ascus no. 62. F. Normal ascus of *Neurospora tetrasperma*. (See text for further explanation.)

Albinistic strains were obtained from other asci from which fewer than five spores germinated. These results are not included in the table. For example two spores from each end of ascus no. 45 mentioned previously were the only ones which

germinated. The two from one end produced albinistic mycelia while the two from the other end gave conidial mycelia. It happened that the conidial haplonts were alike as to sex and opposite to that of the two albinistic haplonts. It would be impossible to say without a fifth spore where either set of factors was segregated. Only spores nos. 1, 2, 3 and 4 were isolated from ascus no. 59 and germinated. Nos. 1 and 2 were found to be of sex A and nos. 3 and 4 were of sex B. The four haplonts all produced conidia. This ascus may have been either like ascus no. 61, in which case the four missing haplonts would have been albinistic; or no. 59 may have been like ascus 56(4 + 8)a where all of the haplonts produced conidia. A fifth spore would have determined the type. The results shown in the table indicate that the factors for sex and the factors for conidia segregate independently. No evidence has been found as yet to prove that both sets of factors can segregate in the same nuclear division. It would be strange, however, if such a type of segregation could not be found in view of the great variation in this regard already discovered.

Wilcox (14, FIG. 2) found four different arrangements of the spores in the asci she studied, but in each case each end of the ascus contained first a pair of spores of one sex, then a pair of the opposite sex. The writer has not happened to find an ascus in which the four spores at the middle, *i.e.*, spores nos. 3, 4, 5 and 6 were all of the same sex. No doubt such arrangements do occur frequently. The same would be true in case of a "hybrid" ascus like no. 56 where factors for conidia are segregated in the second division.

The two types of segregations illustrated in connection with asci nos. 56 and 61 appear to bring about exactly the same result, namely, the production of four different kinds of spores, two of each kind in each ascus. It should be noted however that the relationship of the haplonts that can be mated to produce perithecia is not always the same in both cases. Haplonts of opposite sex from ascus no. 56 are always second cousins, basing the relationship on the number of divisions subsequent either to nuclear fusion or to segregation. There will be 16 possible matings between second cousin individuals which will give

positive results. In case of haplonts from ascus no. 61 there will be eight possible matings between first cousin haplonts which will result in the production of perithecia. The other 8 productive matings will be between second cousin haplonts. "Pure line" albinistic as well as conidial strains can be obtained by inbreeding haplonts from ascus no. 61 only by mating first cousin haplonts. The fusion nucleus in an ascus from a second cousin mating of haplonts from ascus no. 61 will always be heterozygous for conidia.

ALBINISTIC RACE BY SALTATION

Edgerton (8) was among the first to note the effect of the environment on variations in the cultural characters of fungi. Some of the changes described were recognized for what are now regularly called mutations or saltations, as distinct from changes merely transitory, holding only so long as the new environment is maintained. Brown (4), although he erroneously attributed the coining of the word saltation to Stevens, has discussed briefly the use of the terms saltation and mutation to denote the sudden permanent changes in the morphological and physiological characters of fungi which occur in cultures. The art of growing fungi from single spores is so commonly practiced that one is better able than formerly to evaluate results reported by students of fungous variants. This subject will be covered in another paper where the behavior of strain Arl.10 described below will be compared with mutations or saltations previously reported by others.

The four conidial haplonts obtained from ascus no. 56 are typical for the species *Monilia sitophila*, and they resemble more the Columbia University and Cooley strains (13). In analyzing the parent strains to find out if possible, why some of the ascospores from the combination Arl.6 + Arl.10 produce albinistic mycelia, the purity of the stock cultures must first be established. One or the other might contain two mycelia, one of which is albinistic. Both being of the same sex, the mixture would not be manifest under the conditions of ordinary culture work. Again, one of the parent mycelia may have mutated previously and ~~rise~~ rise to an albinistic hyphal branch which did not

produce conidia. In making new cultures by transferring conidia entangled in bits of mycelium the mixture would be continued from culture to culture. In either case there would be a chance when the two parent strains were grown together that the two nuclei which come to fuse in the young ascus would be unlike as to the factors for conidia which they bore. Such an ascus would produce four albinistic and four conidial ascospores. If, however, the perithecium arose from mycelial branches both of which produced conidia, no albinistic ascospores would be formed. The cells of the mycelium, ascogonium and, no doubt, those of the antheridium have more than one nucleus. This makes the situation more complicated than would be the case were each cell uninucleate. As it stands there is no guarantee that all of the asci in a perithecium have the same inheritance. They might be unlike with respect to their factors for conidia alone. All of the ascospores in five of the asci included in TABLE III produced conidial mycelia, but no record was kept as to whether the asci in any single perithecium were all alike in this respect. The results summarized in the table seem to justify the conclusions that one of the parent cultures must have contained some albinistic hyphal elements.

Two methods could have been employed in seeking a solution of the questions involving the origin of such albinistic mycelia from ascospores obtained by mating mycelia both of which apparently produce conidia abundantly. First, a single conidium of each strain could be germinated and the two resulting mycelia mated in culture. If some albinistic ascospores were developed, the mutation responsible might have occurred before fertilization, or there might have been some such change in the sporophytic ascogenous hyphae. Although the two cases are not exactly parallel it may be pointed out that the homothallic mycelium of *Neurospora tetrasperma* produces three kinds of conidia as regards their sex alone (5). This suggested the advisability of comparing mycelia obtained by growing several different conidia from the same culture. The Arl.10 strain which, as noted previously is rather pale in color, appeared to be the most promising for this experiment. The Arl.6 strain would pass generally as typical for *Monilia sitophila*.

SINGLE CONIDIUM CULTURES OF ARL.10

A small tuft of aerial hyphae from a culture of Arl.10 bearing conidia was shaken in a tube of sterile water. Loops of the suspension were spread out thinly on the surface of agar in plates. After the conidia had germinated tip ends of their germ tubes were cut off and transferred. Fifteen single conidium tube cultures were obtained in this way. In all of this work no distinction is made between a conidium and the cells of conidiophore branches which disjoin and function as conidia. Within a few days it was clear that the cultures were not all alike. Ten of the cultures, numbered Arl.10.1 to Arl.10.10 would be classed as albinistic although some of them produced a very few conidia. Five cultures were producing conidia in abundance. They were not at all albinistic. One of these cultures, Arl.10.11, was chosen for further work. Nine single conidium cultures were obtained from this culture, and only one culture was albinistic. Culture Arl.10.11.a which produced conidia normally furnished conidia for a third generation of single conidium cultures. Twenty-eight of these single conidium mycelia were grown on potato dextrose agar and 7 on corn meal agar. Nineteen proved to be albinistic and 16 produced great quantities of conidia. So much aerial growth develops on potato dextrose that it is not possible to determine accurately whether some few conidia are not being formed in a culture which has all the appearance of being albinistic. Again selecting one of the cultures, Arl.10.11.a.1, which was producing conidia abundantly, 22 single conidium mycelia of the fourth generation were secured. Not a single albinistic mycelium was produced. In one case the conidium was allowed to develop further in a plate culture. Tip ends of hyphae were cut off in five different places and transferred to individual tubes. All produced conidia. Mycelium Arl.10.11.a.1 appears to be producing typical orange to golden colored conidia. The results were further checked up beginning with another culture, S, of Arl.10. Twenty-four single conidium mycelia were grown on corn meal agar and 12 on potato dextrose. Eleven of those on corn meal agar produced conidia and 13 were albinistic. Only three of the 12 on potato dextrose produced conidia. Forty-two second generation

mycelia were obtained from culture Arl.10.S.1. Of these 30 produced conidia and 12 were albinistic. Forty-five single conidium cultures from Arl.10.S.1.32 all produced conidia.

While the experiments outlined above involve only comparatively small numbers, it is evident that strain Arl. 10 is unstable in that it is constantly forming some conidia the mycelia from which lack the capacity to produce conidia normally in turn. In the two series representing succeeding generations where selections of conidia for the next sowing were made from cultures producing conidia abundantly, it may be that lines were accidentally secured which are stable. Roberts (11) was forced to proceed to the 57th generation before he succeeded in obtaining a stable race of *Alternaria Mali* from an unstable mutant race. Since some conidia from culture Arl. 10 produce albinistic mycelia there can be no question that some sort of somatic segregation or saltation can occur after a conidium is cut off. Consider then the combination culture Arl.6 + Arl.10, which must now contain many mycelia of both strains because the culture will have been started by inoculating it with many conidia of both strains. Some Arl.10 conidia transferred furnish albinistic mycelia which can mate with an Arl.6 mycelium giving rise to hybrid asci like nos. 56 and 61. Other conidia from Arl.10 are normal and give rise to conidial mycelia which can also mate with Arl.6. All ascospores from such a mating will naturally produce mycelia which will give rise to conidia like ascus no. 58. Only in case Arl.6 should also be throwing albinistic races will there be possible a mating between two albinistic mycelia in this culture.

No ascus in which all 8 spores gave albinistic mycelia has as yet been obtained from a mating of Arl.10 + Arl.6. The one test which was made with conidia from strain Arl.6 suggests that the strain is probably a typical conidial strain which is rather stable. Conidia were sowed on agar and 28 single conidium mycelia obtained in the usual way were grown in tube cultures. After having been incubated for only 24 hours it was found that conidia were being formed in 26 of the cultures. The other two cultures showed many conidia the next day. As noted previously, some of the albinistic mycelia arising

from conidia of Arl.10 do tend to produce a few rather abnormal conidia. This is apt to occur where an aerial hypha grows down from the drying upper edge of the agar slant. The fact that some conidia are formed, even though they are not colored and are not exactly normal otherwise, is proof that the mycelium producing them possesses some conidial inheritance. It has also been found that not all of the conidial strains of the first generation sowing are equally prolific in this respect.

The size of the monilioid conidia of species of *Neurospora* is determined, in part at least, by the number of nuclei which they receive. Should some irregularity occasionally occur in the nuclear divisions preceding spore formation in strain Arl.10, one can readily see how different kinds of conidia might arise. Some conidia would be perfectly normal, others might be albinistic, and still others would be intermediates, because they would have been provided with different kinds of nuclei.

One experiment was tried out to see what would result when one of the albinistic types of mycelia derived by selection of conidia from Arl.10 was mated with an albinistic mycelium of the opposite sex derived from a hybrid ascus. Strain Arl.10.3 seems to be producing no conidia on corn meal agar. This strain was mated with haplont no. 56.6. Perithecia matured very quickly. Twenty-seven single ascospore cultures were obtained in the usual way. All of their mycelia were albinistic, indicating that such a mycelium arising through gametophytic somatic segregation does not differ so materially from one derived from an ascospore following segregation during reduction divisions of a diploid mother cell. Somatic changes described above certainly do not always result in the production of absolutely sterile albinistic races. The same thing very likely will be found to be true for segregations during meiosis. In any event an albinistic strain can be mated with a conidial strain with the result that four of the eight spores from an ascus will give rise to albinistic mycelia. Furthermore these albinistic haplonts are not all of one sex so that two of opposite sex can be mated and their progeny will all be albinistic. No other case has been reported in ascomycetes where a form derived through a mutation or saltation has been bred or reproduced

sexually to determine whether the mutation had involved factors which would be redistributed during the divisions of the nucleus of the mother cell. Such an experiment must have been possible, particularly with species of *Aspergillus*, *Neocosmopora*, *Glomerella*, *Diaporthe*, and *Penicillium*.

MICROCONIDIA

Certain ascomycetes produce two very different kinds of asexual fruit bodies. *Pezizella Lythri*¹ is a good example. The asexual Hainesia form represents the conidial stage. The patelate sporodochium is a very delicate fleshy structure which forms quantities of spores, quickly dispersed whenever supplied with moisture. The non-ostiolate pycnidium is a very resistant thick walled structure resembling a sclerotium, hence its name Sclerotiopsis. This stage is well adapted for carrying the fungus over winter. The spores of these two very unlike fruit bodies cannot be distinguished, and they serve the same purpose once they are discharged naturally. It is the structures producing the spores which differ in their secondary function. *Phoma uvicola*, the pycnidial stage of a species of *Guignardia*, has rather large oval to spherical spores. Along with these pycnidia, or independent of them in culture or on the host plant, there may be formed "micropycnidia," spermbgonia, as they are often called, because of the many small rod-shaped spermatium-like bodies which they produce. No one has ever germinated these little bodies and opinion is divided as to their probable nature. Perithecia of species of *Guignardia* develop rather sporadically and this suggests that the "spermatia" may function in some way in bringing about fertilization. One occasionally finds a few normal pycnosporos among hundreds of spermatia in spermogonia of *Phyllostictina carpogena* (l.c.). This would indicate that cells of the central region have the capacity to develop either microspores or pycnosporos.

A pycnidium of *Sphaeropsis malorum* occasionally discharges* small elliptical hyaline spores along with the large brown spores which are characteristic of the species. In this case the microspores do not resemble spermatia. They are probably true

¹ Jour. Agr. Res. 23: 743-759. 1923.

spores. Pycnidia of some species of the old form genus *Phomopsis* develop two kinds of spores. Are the so-called stylospores spermatia, or are they simply paraphyses or perhaps a second kind of pycnospore?

Everyone who has cultured species of *Sclerotinia* is familiar with the minute bodies which are budded off from clusters of short flask-shaped hyphal branches. These spermatium-like bodies have long been referred to as microconidia. Once a culture has begun to produce microconidia great masses of them accumulate at the expense of the production of normal conidia. There has been much speculation as to their probable function. Brefeld (1), Woronin (16, 17), Roberts and Dunegan (12), Wormald (15) and others have tried repeatedly to germinate microconidia and have always failed. Since they do not germinate under ordinary conditions they would not seem to be a very efficient means of propagating the fungus. Humphrey (10) claims that the microconidia in his cultures of *Sclerotinia fructigena* germinated readily and the mycelia from them produced *Monilia* conidia. Other authors who have worked with this species are disposed to question Humphrey's statements in this regard.

It would be a difficult matter to separate the species of *Neurospora* on the basis of the shape and size of their *Monilia* conidia because there is no criterion by which to distinguish with certainty, especially in old cultures, between true conidia and fragments of conidiophores. There is also the greatest variation in the size of the true conidia. In old plate cultures one readily finds where some conidia have germinated giving rise to narrow germ tubes from the ends of which very small ellipsoid secondary conidia are budded off. These little conidia in turn germinate with still shorter and narrower germ tubes from which tertiary conidia are formed. The conidium-like supporting cells at the junction of two conidial chains are larger than true conidia, but when they become disjoined and set free they tend to round out and resemble over-sized conidia. The method of branching of the aerial hyphae of albinistic strains, as noted previously, is suggestive of a relationship of such races to a *Botrytis* or a *Monilia*, and there is a tendency to form torulose or *Polythrincium*-like

constrictions along the end branches. If they should extend to the center, a chain of true conidia would be formed in normal fashion.

Ordinarily the mycelium of *Monilia sitophila* produces conidia in great quantities and no one has even raised the question of the production of microconidia by this species. It was, therefore, of interest to learn that true microconidia were being developed in some Petri dish cultures of the albinistic races such as no. 56.6. The microspores are borne laterally and terminally on short rather blunt branches which are developed in loose clusters at intervals along a hypha, just as figured by Woronin (17, PL. 3, FIG. 38-44) for *Sclerotinia cinerea*. The branches are, however, from three to six cells in length and not flask-shaped (PL. 9. b). The microconidia are minute hyaline spherical to pear-shaped bodies about $2.5-3.5\ \mu$ in diameter (PL. 9, a). Under ordinary high power one sees the bright spot at the center of the spores just as noted and figured by several authors. Examined with an oil immersion lens, however, no such spot is evident. They are at first held together in drops of water of guttation, small drops seemingly budding off from larger drops. Microspores appear to be developed usually at only one point from each cell. A sort of collar-like projection develops at that point and in optical section, it looks as though there were an opening at this point through which partly formed spores are being extruded. When first discovered the microconidia were mistaken for *Coccus* bacteria. In order to find out just what the culture appeared to be contaminated with, masses of the little bodies were spread over the surface of an agar plate in a film of water. A poured plate was also prepared in the ordinary way. Instead of developing colonies of bacteria as was expected it was found at the end of two days that short germ tubes were being formed, proving that the little bodies first taken for bacteria were really fungus spores: Microconidia swell greatly and elongate as a whole during germination (PL. 9, e). Tip ends of single germ tubes were cut off and transferred to tube cultures and single germinating microconidia were also isolated and transferred. The mycelium developed very slowly at first as compared with the rate of growth proceeding from a

Monilia conidium. Within a few days the cultures developed aerial hyphae and began to resemble cultures of the parent albinistic race, and it was not long before they could not be distinguished.

The mycelia derived from microconidia formed on mycelium 56.6 have been mated with the albinistic mycelium 56.2, and with mycelia derived from monilioid conidia, with the result in all cases that perithecia were formed in the usual way. This proves conclusively that the microconidia of these strains of *Monilia sitophila* are true spores. They differ from the monilioid conidia in their shape, size, manner of development and in their type of germination. They are entirely distinct morphological structures and probably are represented by a separate set of genetic factors. If so it provides another character which may be considered in breeding these fungi. Some microconidia are very likely produced in cultures of races characterized by their abundance of monilioid conidia. The secondary and tertiary conidia found in plate cultures particularly, have quite a different origin, as noted above, and vary greatly in size. Microconidia have been found in plate cultures of albinistic haplonts of both sexes so that one can scarcely attribute to them the sole function being accorded to true spermatia. They are clearly homologous to the microconidia of *Sclerotinia*.

Due to their very small size, delay in germination and slowness of growth of their young mycelia, microconidia, should they be present in *Monilia* cultures like Arl.10 must always be reckoned with as a source of contamination. The albinistic saltants obtained from single monilioid conidia of Arl.10 reported previously (p. 26) can be distinguished readily on the second day. Microconidia, if accidentally transferred, would have just begun to develop branched germ tubes by this time. This work was done before it was discovered that microconidia were being developed on albinistic mycelia. As a further check, therefore, a new set of experiments was carried out. Conidia from Arl.10 were sowed on an agar plate and allowed to develop long enough to produce fresh conidia for a new sowing. The plate was carefully examined for signs of microconidia, and none being found, another sowing was made to get still another new crop

of conidia for the final test. Three days later 28 mycelia were isolated from germinating conidia. At the end of the second day it was clear that 12 cultures were producing conidia abundantly and 16 had the appearance of being albinistic. There is no question that the saltant mycelia arise directly from germinating monilioid conidia and not from microconidia.

When *Neurospora sitophila* is crossed with *N. tetrasperma* (4) the F_1 ascus usually develops eight spores. In the case of such interspecific hybrids it is scarcely to be expected that the f_1 haplonts would prove to be exactly like either parent in the matter of inheritance affecting the number of spores in an ascus. Sixty f_1 spores were germinated and their mycelia were tested out by mating those of opposite sex, and by back-crossing them with each of the parent mycelia. None of these f_1 haplonts was found which would, when mated, produce perithecia with either eight spored asci like the *N. sitophila* parent or four spored asci like the *N. tetrasperma* parent. From the standpoint of morphology alone one might well believe that 8-sporedness as contrasted with 4-sporedness would not be found to be determined by a simple set of conditions. The final disposition of the eight nuclei in the ascus of *N. tetrasperma* so that each spore will include a nucleus of each sex is determined largely by the orientation of the nuclear spindles. This in turn is affected by the shape of the ascus. The shape of the ascus must depend somewhat on the size of the perithecial cavity and the number of asci maturing at one time. Of the three species of *Neurospora*, *N. crassa* has the largest perithecium and the longest and narrowest asci.

In making the selections (l.c., p. 9) to obtain 8-spored and 4-spored segregates, mycelia were chosen for the resemblance of their conidial masses to those of *N. sitophila* or *N. tetrasperma*. The results of culture experiments with strains Arl.6 and Arl.10 described above indicate that production of conidia probably is entirely independent of the number of spores developed in the ascus, therefore such a method of selection was not particularly advantageous.

Some new interspecific hybrids will be described in another paper to appear shortly. At that time there will be an opportunity for a further discussion of the various questions raised

in the present paper, as well as the subject of gametophytic inheritance in general.

SUMMARY

Asci from cultures in which strains Arl.6 and Arl.10 of *Neurospora sitophila* are mated are not all alike. Some asci produce spores which differ primarily only as to their sex. All 8 spores in the ascus develop mycelia which form monilioid conidia normally. Other asci produce four different kinds of spores, two of each kind. The spores differ not only as to sex but in the types of mycelia which they develop on germination. Two spores of each sex give rise to albinistic mycelia which are practically sterile as regards their ability to produce monilioid conidia. Two spores of each sex are typical and their mycelia develop masses of orange colored conidia. In such asci the spores may alternate two and two as to sex and four and four as to being albinistic as contrasted with typical; or the spores may alternate four and four as to sex, and two and two albinistic and typical. The particular distribution of the spores in the ascus depends upon whether the factors for sex and factors for conidia are segregated during the first or the second nuclear division in the ascus.

A new race of *Neurospora sitophila* which can be propagated indefinitely by sexual reproduction has been obtained by mating two albinistic haplonts of opposite sex.

A culture of strain Arl.10, originally derived from a single ascospore, now develops two kinds of monilioid conidia. Conidia of one kind produce typical mycelia which form conidia normally; other conidia, as the result of a saltation or some sort of somatic segregation develop albinistic mycelia, which are very much like the albinistic mycelia derived from ascospores following segregations during meiosis. Some of the former, however, do produce a few colorless and otherwise abnormal conidia. By selecting conidia from Arl.10 through a few generations mycelia were obtained which appear to be typical and stable.

Strain Arl.6 is a typical stable conidial strain.

The albinistic races of both sexes develop true microconidia which are comparable to microconidia of species of *Sclerotinia*. These microconidia germinate and produce albinistic mycelia

which can be mated. The perithecia are normal in every respect except that their ascospores will be albinistic. Microconidia of *Neurospora sitophila* are distinct morphological structures not to be confused with the monilioid conidia. Whether or not typical *Monilia* strains produce microconidia has not been determined.

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EXPLANATION OF PLATES

Neurospora sitophila

Small green circles on tubes indicate haplonts A; red circles, haplonts B.

PLATE 8

Cultures of the eight haplonts derived from ascus no. 56 from a mating of strains Arl.6+Arl.10. Albinistic haplonts nos. 1, 2 and 5, 6 are practically sterile as to production of conidia. Haplonts nos. 3, 4 and 7, 8 are normal for the species, producing an abundance of conidia. Segregation of the sex factors occurred in the first nuclear division in the parent ascus and segregation of factors for conidia in the second division. Four genotypically different kinds of clons from one mother-cell.

PLATE 9

a-d. Microconidia from a plate culture of the albinistic clon no. 56.6. b. Small branches producing microspores. e. Germinating microconidia from the same sowing about 40 hours later. Note how the microspores swell during germination. (a, b and e $\times 270$; c, d $\times 315$.)





MONILIA SITOPHILA
(Microconidia)

STRAW COMPOST FOR MUSHROOM CULTURE ¹

ILLO HEIN

Artificial farmyard manure with many of the properties of composted stable manure has frequently been made with success from straw. The use of such artificial manure for mushroom growing, however, has hitherto been given little attention and is not reported in the literature. Studies on substitutes for the mushroom compost now in use are being conducted in the department of Botany at The Pennsylvania State College and for this purpose an experimental mushroom house has been constructed (Hein, 1929).

That cellulose splitting organisms require an abundant supply of available nitrogen is generally known and this fact has been studied especially by investigators interested in the conservation of nitrogen in the soil. Carbohydrates are said to provide energy food for, and thus stimulate the growth of, nitrogen feeding organisms. For the decomposition of cellulose it appears that a larger supply of nitrogen than is ordinarily found in straw, corn stover, hay, etc., is necessary. Studies on the natural decomposition of cellulose have shown that both chemical and biological activities are concerned. The data in the literature under this head has recently been summarized by Bradley and Rettger (1927). The decrease in nitrate supply due to the presence of plant food materials of high carbon content has been reported by Kellerman and Wright (1914), Hill (1915), Doryland (1916), Lemmerman and Einecke (1919), Briscoe and Harned (1918), Rahn (1919), and many others. Collison and Conn (1928) state that cellulose has a stimulating effect on nitrate feeding organisms but also find that plant products high in cellulose have a toxic effect on young seedlings.

Hutchinson and Richards (1921) have reported the production from straw of a well rotted manure which closely resembles

¹ Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station as Technical Paper No. 489.

ordinary stable manure in color, structure and odor. According to them the essential conditions for making artificial manure from straw are, air supply, suitable temperature, and a supply of soluble nitrogen compounds as food for the fermentation organisms. A slightly alkaline reaction is necessary and this should never be higher than the upper limit of tolerance of the organisms. Halverson and Torgenson (1927) report similar successful studies and state that the soluble nitrate compounds applied to the straw as food for bacteria, ammonium sulphate with the addition of lime to neutralize the acids formed, proved most satisfactory and economical. Albrecht and Poirot (1928) attempted the practical application of the methods of previous workers and produced good manure from wheat straw. Field tests using straw manure showed improvement in yields of wheat and of sweet clover, the yield in the latter case being even greater than that obtained from the application of barnyard manure.

Wheat straw was composted in heaps to which nitrogen compounds in various forms were applied. The composting was carried on outdoors during the spring months and indoors during the winter months.

The following tables give the results of some of the successful tests in mushroom production from the manure made by composting straw both with and without the addition of other food materials for the cellulose decomposing organisms. The compost heaps were made up in closely adjoining piles approximately 4 x 9 x 8 feet high. The pile in the beginning was many times the volume of later stages when the straw had lost its stiffness. The volume reduction of the straw after decomposition was similar to that shown in figure 1, p. 125, by Albrecht and Poirot (1928). This fact made the straw pile a little difficult to handle. Both treated and untreated heaps showed a rapid rise in temperature after a few days. The greatest difficulty was experienced in thoroughly wetting the straw during the early stages. Since the water rapidly seeped through the comparatively loose piles, the straw could not in the beginning be adequately moistened. The method of at first watering the straw lightly as suggested by Hutchinson and Richards (1921) and then watering heavily

TESTS MADE WITH WHEAT STRAW

Nitrogen compound added to straw	Amount	pH at time of making up beds	Mycelial growth	Yields per sq. ft. during first 28 days of bearing period
Manure from old spent mushroom bed	1 part in 10 by vol.	7	Slow at first but good growth later	8 oz.
	1 part in 50 by vol.	7.5	Good growth	5 oz.
	1 part in 100 by vol.	6.5	Good	6 oz.
Rich garden soil	1 part in 10 by vol.	7	Fair growth in beginning	0
	1 part in 50 by vol.	6.5		Few buttons
	1 part in 100 by vol.	6.5	Good	6 oz.
Fresh horse manure	1 part in 10 by vol.	7	Fair	Few buttons died later
	1 part in 50 by vol.	7.5	Fair	8 oz.
	1 part in 100 by vol.	7.5	Good	4 oz.
Liquid horse manure	20 gal. per 100 lbs. straw	7	Good	12 oz.
Ammonium nitrate	1 lb. per 100 lbs. straw	7.8	Fair	5 oz.
Ammonium sulphate and lime	1 lb. per 100 lbs. straw	6.5	Very good	4 oz.
Ammonium phosphate	1 lb. per 100 lbs. straw	6.5	Very good	5 oz.
Ammonium carbonate	1 lb. per 100 lbs. straw	7	Good	0
Check			Good	13 oz.

after the initial fermentation had been going on for a few days proved satisfactory from the point of view of water absorption by the straw.

Where good garden soil or manure was used as a source of nitrate the material was simply stirred with the straw by forking over. The soluble nitrates were dissolved in water and applied

with a watering can four days after the initial fermentation had begun.

The H-ion content was determined by the colorimetric method just before the finished product was made up in beds. Yield was estimated on the basis of average weight of the mushrooms per square foot. Yields were poor as compared with those obtained in the horse manure check beds and with the yields ordinarily obtained in commercial practice. Certain patches produced no mushrooms while others produced a fair stand. The low yields were perhaps due more to unfavorable environmental factors, since with the equipment available at the time, humidity and temperature conditions could not be adequately maintained. I am of the opinion that better yields than those here recorded can be obtained with straw manure under more favorable environmental conditions and further experimental work along these lines is under way.

The results obtained show no consistency nor can conclusions be drawn other than that mushrooms can be produced on straw manure. The yield from beds of horse manure compost made up at the same time as the above beds were only slightly better so that undoubtedly other factors were responsible for the low yields. Under properly managed environmental conditions better production should be obtained.

Further studies with straw and other substitutes for horse manure are soon to be reported.

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NOTES AND BRIEF ARTICLES

Mushrooms of Field and Wood is the title of a small well illustrated volume just issued by Miss Margaret McKenny and published by the John Day Company of New York. Many of the older and popular volumes on mushrooms are out of print and inaccessible and one is always interested in the new volumes that are coming off the press. The editor of MYCOLOGIA is repeatedly called upon to recommend books which can be used by the amateur who wishes a very general knowledge of the common forms to be found in the woods and fields. This volume has been issued primarily to fill such a need. While it is not intended exclusively for the mycophagist, many of the poisonous and edible species are illustrated. Most of the space is devoted to the Basidiomycetes. Only a limited space is devoted to the Ascomycetes. The work is intended largely for the use of Girl Scouts and similar organizations, and will doubtless be widely used by young nature lovers who wish to familiarize themselves with these plants.

A most important addition to botanical literature has recently been issued from the Farlow Herbarium of Cryptogamic Botany and dedicated to the memory of William Gilson Farlow. This Host Index of the Fungi of North America, published June 10, 1929, has been compiled by Professor Arthur Bliss Seymour and includes in its 732 pages some 80,000 names of hosts and fungous parasites. Bacterial pathogens of plants and fungous parasites, with a few exceptions, of the higher animals, including man, are not listed in this work. The geographical area includes the whole of North America, the Island of Trinidad and Panama to the northern limits of plant life, from Greenland to Alaska. One must agree with the compiler that no pains have been spared to make the index as complete and accurate as possible. It has been attempted to include all reports in the literature covering the area mentioned for the past 50 years. Mycologists and pathologists will find this work of great value.

The Fungi of Manitoba by G. R. Bisby, A. H. R. Buller and John Dearnness with a preface by E. J. Butler, Director of the Imperial Bureau of Mycology at Kew, England, has just been issued. This book includes a record of nearly 2000 species of fungi which have been collected in the province of Manitoba, 45 of which are described as new. The list is preceded by a general discussion of 49 pages and is followed by a host index and an index of substrata and also an index of classes, orders, families and genera. The list includes a number of rare species. In the Discomycetes, the writer is interested to note the record of some rare forms, among these, *Underwoodia columnaris*, *Ascobolus strii-sporus*, *Elvela sphaerospora* and *Plectania hiemalis*. The last-named species which is apparently common about Winnipeg has been encountered by the writer just once in the preparation of North American Cup-fungi. Since the fungi are quite cosmopolitan the list presented here would probably fit most any region in temperate North America. The volume is very neatly gotten up and a creditable piece of work. Two of the authors, A. H. R. Buller and J. Dearnness are Associate Editors of MYCOLOGIA. Copies are available from Prof. V. W. Jackson, Manitoba Agricultural College, Winnipeg, Canada, at two dollars and fifteen cents, postpaid.

TWO NOTABLE PAPERS ON SLIME MOULDS

1. In the latest volume of the *Transactions of the Royal Society, Edinburgh*, the opening paper—issued indeed as a “separate,” March, 1928—has perhaps only recently reached readers in the open libraries of the world.

This paper is in every way important. It makes appeal to the readers of *Mycologia* but almost quite as well to all morphologists, cytologists at least, whether students of plants or animals. The subject is nothing more nor less than the “*Life-history and Cytology of Reticularia Lycoperdon* Bull.,” one of the larger æthalioid species of the slime moulds. From field, to laboratory and from laboratory to field again, for many months, Dr. Malcolm Wilson and Miss Elsie J. Cadman, aided by the latest physical equipment and chemical reagents, have at the University of Edinburgh pursued their researches, now

before us as a beautiful monograph of nearly a hundred quarto-pages, followed by seven fine collotype plates, bearing more than a hundred figures, chiefly from the microscope; bringing to the careful reader almost a personal experience of the facts which support the evenly progressive argument of the authors.

This note is not intended to be a review; those interested will read for themselves. But readers of MYCOLOGIA will be interested to know that, in the group named, life-histories are the exception; that few species have been set out with the fullness of detail seen here; none in such luxurious form. Dr. Jahn of Münden, Hannover Germany, has worked far longer, and has examined a number of species, especially the STEMONITES; but facilities for publication and illustration have not been at his disposal. Dr. Jahn's research has covered much the same ground and his work is recognized by the Scots throughout, and—except in one notable instance—is confirmed.

The spores of the Myxos, as all students know, give rise to amœbæ which presently become ciliated swarmspores; but later—as hitherto reported—resume the amœboid condition and conjugate to form the units whose repeated division and association constitute the vegetative, sporophytic phase—the *plasmodium*. In the *Reticularia* species now before us the *swarm-cells themselves* conjugate and form the plasmodium directly, losing their cilia. The zygote is the plasmodium and is nourished—at the outset, at least—by coalescent non-conjugant swarmspores; myxamœbæ in *Reticularia* are none.

But as stated this does not pretend to be a review; it is but an attempt to call attention of naturalists to an important piece of work. Curiously enough, the authors find themselves not seldom in presence of situations not dissimilar to those characterizing plants—the higher plants in fact—the sequence of meiosis, notable.

2. *Les Myxomycètes de Moldavie* (Moldavie), par M. le Professeur Marcel Brandza, *Bull. du Bulletin de la Soc. Mycol. de France*, Tome XLIV, Fascic. 3, pp. 249–299; pl. xiv–xvii.

Professor Brandza is a member of the staff of the University of Roumania, Bucarest. The work, of which he tells the world, was done at a distant point in the growing kingdom, viz.:—at

"Neamtz"; and to save the blushes of readers and reviewers generally, he kindly includes, parenthetically, the name of the province in which "Neamtz" has place—*Moldavie*—(en français).

Prior to the world war, as all men know, Roumania consisted mainly of two provinces; south, Wallachia, extending east and west, from the Iron Gate to the Black Sea; a well-watered plain, between the Danube and the Transylvanian Alps; and north, Moldavia, stretching north and south, the Sereth, its river, draining the eastern face of the Carpathians, the topography a dissected peneplain, as Stieler shows it—cut and carved by river, fork, branch, brook and rivulet—back to the perennial springs that seep from mountain-sides or banks of frozen snow.

Now as history will have it, the name Neamtz is at once that of a river, a city and a *monastery*, all associated in the north-west corner of the province; the Moldavia river, if you please, of the Sereth a principal fork, receives a branch, the Neamtz water, as if direct from the mountains; but itself breaking, dividing, amid the rising foothills, into brooks and rivulets uncounted. On one of these brooks, branch of the Neamtz river, the old monastery finds its place.

Fine! This page before him, any naturalist would say: This is a place for trees! Here we look for forest primeval; and lo—here the forest stands. Not the forest primeval perhaps, but no doubt a very considerable part of it, saved in large part by conservative monks, who in forest and high cañon found escape from destruction by Turk and Crusader, and for centuries controlled vast areas down to times quite recent. In 1864, indeed, the government resumed a large part of the really most valuable woodlands, leaving to the monasteries greatly diminished holdings, but after all, sufficient to show some of the ancient woodland quite in primitive condition—which brings us to Professor Brandza's thesis. The scholarly professor, a student of Myxomycetes, proposes for the group cosmopolitism, established by the number of species taken at and around the old monastery as centre.

He has been at work twelve years within an area not exceeding four miles in diameter, nowhere surpassing 2300 feet in highest altitude. Within this small but charmed circle, he finds 181

species, of which he gives annotated descriptions; two of these and one variety, new to science, he figures in color. He finds that he has 84 per cent of the forms of Europe, considering the altitude limitation, and 76 per cent of European species as a whole.

Besides this he has found many species, hitherto discoverable only in other parts of the world; or, if in Europe at all, only rarely in this list we find several of our American forms.

Citing all these remarkable facts our author concludes: "The concentration of so great a number of species upon a surface so restricted as that of our researches at Neamtz, affords certain proof that the conditions favorable to the life of these lower organisms (humidity, substratum, warmth) are the only factors essential, determining their appearance in any region anywhere upon the globe. If we except the Alpine species we may say that all other species show in general a manifest tendency to cosmopolitism."

That we may see the extent and real character of his small domain we are early confronted by a little map in the text, which illustrates beautifully the erosional topography—the hills and valleys and streams which an abiding fraction of the deciduous forest about the monastery of Neamtz no doubt still overshadows and adorns.

T. H. MACBRIDE



G. BRESADOLA. W. A. MERRILL

MYCOLOGIA

VOL. XXII MARCH-APRIL, 1930

No. 2

BRESADOLA ¹

WILLIAM ALPHONSO MURRILL

(WITH PLATE 10)

How did Bresadola become one of the greatest mycologists? The answer should be very encouraging to young naturalists in almost any part of the world, no matter how far removed from libraries and museums.

Born in an humble and obscure home, with few of the so-called "advantages" of modern life, he nevertheless improved his opportunities as they came; working devotedly, conscientiously, and with determination.

Busied with affairs of the Church, mycology was with him a side-issue—a hobby—until very late in life. He loved the mountain forest and studied the plants as a diversion, finding rest, peace, and contentment in the green solitudes. I have walked with him for hours in his beloved Tyrol, hardly speaking a word until we happened upon something unusual.

When he made specimens, he made *good* ones, selecting good plants and drying them with great care. Thus he built up a splendid herbarium, containing quantities of duplicates for exchange. As these were carefully studied and properly named, he had no difficulty in trading them for other specimens which did not occur in his own territory. Naphthalene was used freely by him and no insects were allowed to develop in his herbarium.

When curators of museums found him expert, careful, and honest, they loaned him type material in abundance; and this,

¹ Bresadola, Giacomo. Born February 14, 1847. Died on June 9, 1929. [MYCOLOGIA for January-February (22: 1-48) was issued December 31, 1929]

studied at leisure, gave him a rare insight into European species and nomenclature. In this way, although too busy and too poor to travel, the advantages of travel were brought to his door.

In the matter of language, also, he improved his rather exceptional opportunities. In talking with me, he used Italian, French, and German with facility, often throwing in a passage of Latin or Greek without knowing it. He could speak, I believe, eight languages fairly well and read a number of others. English pronunciation, however, always proved a stumbling-block too difficult for him to master at his age.

He used his knowledge of language to good purpose in conversing with visiting botanists, reading pamphlets sent to him, and carrying on an extensive correspondence with mycologists in other lands. Linnaeus hated Latin until he discovered that it was the language of botany; Bresadola took to language, both alive and dead, as a duck to water—and it served him well.

Much might be said of the work and writings of this great, good, kind-hearted man; but why repeat what is already well known to most mycologists? I wished only to say a word to the young naturalist who is struggling along under disadvantages. Bresadola began at his doorstep and by careful, devoted study gradually became acquainted with certain plants in his own neighborhood. He developed and used all his natural powers, and the circle of his acquaintance widened until it embraced the world!

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—X. ASCOTREMELLA¹

FRED J. SEAVER

(WITH PLATES 11 AND 12)

In 1917 Dr. H. M. Fitzpatrick of Cornell University sent the writer some fungi which, without microscopic examination, were at once pronounced tremellaceous species since they were decidedly tremelloid in consistency. The specimens were later found to be ascigerous and referred by the late Dr. E. J. Durand to *Haematomyces faginea* Peck, a species and genus entirely unknown to the writer at that time. The material was named and filed away for future study.

Recently the writer undertook a detailed study of the genus *Haematomyces* as represented by the species named above. The type was borrowed from the State Museum and a detailed study at once showed it to be different from the material sent from Ithaca, although apparently congeneric.

In the meantime (1919) specimens were received from Dr. Dearness of Ontario which did agree perfectly with Peck's specimens and description. These were determined by the writer and incorporated in the collection. Recently it was learned that Dr. Dearness had excellent photographs of this species made from fresh material and the writer has secured prints which he has been permitted to use through the courtesy of Dominion National Museum of Canada.

In the course of these studies it has been concluded that there are two different forms which the writer regards as distinct species. It has also been learned that Dr. Durand had recognized two forms as shown by notes sent from the Department of Plant Pathology at Ithaca although there is nothing to indicate

¹ This paper is preliminary to a monograph of North American Cup-fungi (Inoperculates), a companion volume to North American Cup-fungi (Operculates), which was published by the author and issued in December, 1928.

that he regarded them as specifically distinct. Probably his studies had not been carried far enough at that time.

Since little is apparently known of these forms, it seems very appropriate to publish at this time the excellent photographs received through Dr. H. M. Fitzpatrick of Cornell University and Dr. John Dearnness of Canada, together with diagnoses of the species as the writer understands them.

STATUS OF THE GENUS HAEMATOMYCES

The genus *Haematomyces* was founded by Berkeley and Broome on material collected in Ceylon. As pointed out by Petch (Ann. Bot. 33: 405. 1919) and others, the type species *Haematomyces spadiceus* is not a fungus at all but a resinous exudation. Petch, however, suggests retaining the name in the sense later used by Peck and others. This is not a satisfactory solution of the matter since the genus as first used by Peck contained one species, *Haematomyces orbicularis*, which according to Peck was congeneric with *Haematomyces vinosus* Cooke & Ellis, which is in turn not a *Haematomyces* in the sense that Petch intended it but a *Haematomyxa*. *Haematomyces* Peck then is a straight synonym of *Haematomyxa* Sacc. and could not be used for the forms here described.

The writer, therefore, proposes the name **Ascotremella** nom. nov. for the American forms here described which are tremelloid in substance but ascigerous in fruit. The one form *Haematomyces fagineus* Peck has occasionally been collected and should be designated as the type of the proposed genus *Ascotremella*. So far as can be determined, the genus belongs with the inoperculate section of the cup-fungi. Owing to the excessive shrinking of the plants in drying it is not easy to study this character. One species reported by Petch from Ceylon which seems to belong to this genus is described as having non-operculate asci. The genus has all of the symptoms of being an inoperculate. The writer has had no opportunity to study fresh material. The following is the writer's conception of the genus as represented by the two American species known.

Ascotremella Seaver, nom. nov.

Haematomyces Authors (in part) not Berk. & Br. Jour. Linn. Soc. 14: 108. 1875.

Apothecia densely crowded or cespitose, tremelloid sessile or substipitate; asci cylindric but often much swollen so that the spores appear relatively small 8-spored; spores ellipsoid or more or less irregular in form, usually containing two small oil-drops, hyaline; paraphyses slender, simple or branched.

Type species, *Haematomyces fagineus* Peck.

Apothecia forming cerebriform masses..... 1. *A. faginea*.
Apothecia cespitose, turbinate..... 2. *A. turbinata*.

1. Ascotremella faginea (Peck) comb. nov.

Haematomyces fagineus Peck, Ann. Rep. N. Y. State Mus. 43: 33. 1890.

Apothecia tremelloid, cerebriform, reaching a diameter of 2–4 cm. or forming a continuous mass 8–10 cm. in extent, gyrose-lobate, smooth, shining, raisin colored without and within, the substance gelatinous, becoming horny when dry; asci subcylindric, reaching a length of 50 μ and a diameter of 6–7 μ ; spores usually 1-seriate, narrow-ellipsoid, hyaline, 4–5 \times 7 μ ; paraphyses slender, slightly enlarged above.

On trunks of beach, *Fagus americana*; also reported on *Tilia*.

TYPE LOCALITY: Rainbow, Franklin Co., New York.

DISTRIBUTION: New York and Ontario.

ILLUSTRATIONS: Ann. Rep. N. Y. State Mus. 43: pl. 4, f. 5–7.

2. Ascotremella turbinata Seaver, sp. nov.

Apothecia extremely gelatinous, closely crowded when young, giving rise to cespitose clusters as they mature, the individual apothecia at first rounded, becoming turbinate or subturbinate, externally light colored, reaching a diameter of about 2 cm. and of about the same height, the substance shrinking to a thin film when dry; hymenium much darker than the outside of the apothecium, brownish, nearly circular in form, convex, plane, or very slightly concave, even or nearly so, occasionally with a few folds about the margin; asci cylindric or subcylindric, often strongly swollen; spores small ellipsoid, 3–4 \times 6–7; paraphyses slender, often branched.

On rotten wood.

Type collected by Dr. H. M. Fitzpatrick in Taughannock Gorge, near Ithaca, New York, October 7, 1917.

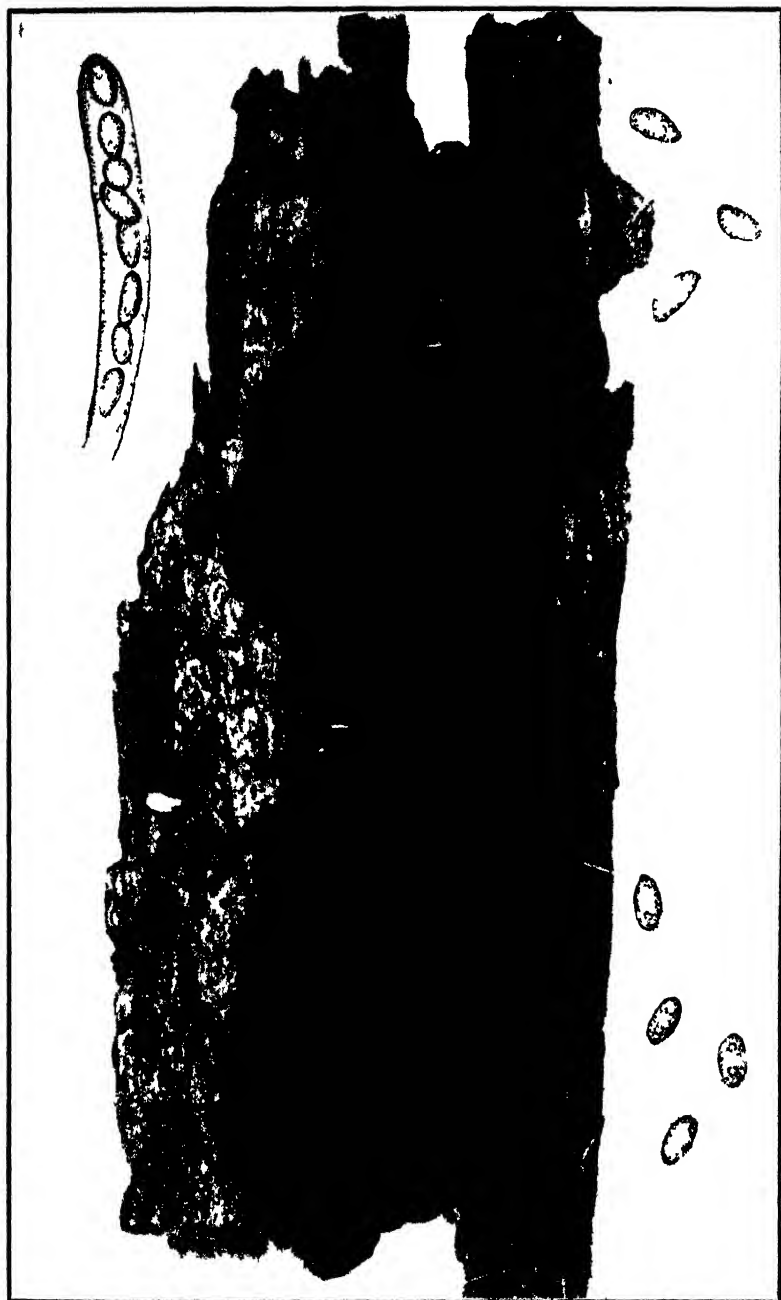
DISTRIBUTION: Known only from the type locality.

THE NEW YORK BOTANICAL GARDEN

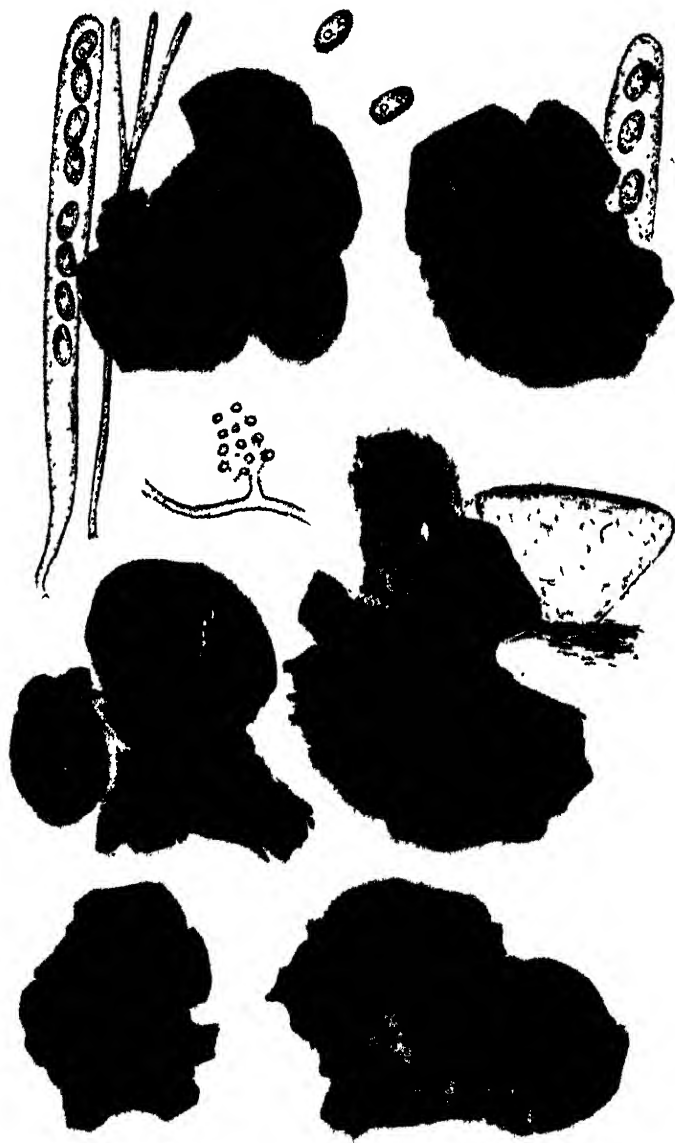
EXPLANATION OF PLATES

Plate 11. *Ascotremella faginea* (Peck) Seaver. Photograph of apothecia, about natural size, with drawings of asci and spores. Photograph by Dominion National Museum, Canada.

Plate 12. *Ascotremella turbinata* Seaver. Photographs of apothecia, with drawings of asci, spores, and diagram of section of an apothecium. Photographs by W. R. Fisher of Cornell University.



ASCOTREMELLA FAGINEA



ASCOTREMELLA TURBINATA

A NEW TRICHOGLOSSUM

J. W. SINDEN AND H. M. FITZPATRICK

(WITH PLATE 13)

The genus *Trichoglossum* was separated from *Geoglossum* by Bondier (1) because of the presence of setae in the ascoma. These occur in both the stem and ascigerous portion and give the plant a velvety appearance. Durand (2) recognizes the genus in his *Geoglossaceae of North America*. He has extended knowledge of it by a careful study of the North American species and has included several new forms.

Although in other genera of the family species are separated by characters such as the nature and shape of the paraphyses, the form and color of the ascomata, the size of the asci, and the color, shape, size, and septation of the spores, Durand, after examination of a wealth of material, concluded that in *Trichoglossum* the only characters constant enough to be of use in separating species are the number of spores in the ascus and the spore length and septation. Of these characters he considers spore length to be of primary value in separation. On this basis he recognizes in his monograph five species. He separates them as follows:

- A. Spores normally 100–170 μ long, narrowed each way from above the middle.
 - B. Spores 4 in each ascus, 8–11-septate.. 1. *T. velutipes*
 - B. Spores 8 in each ascus.
 - C. Spores 15-septate..... 2. *T. hirsutum*
 - C. Spores 7–14-septate..... *T. hirsutum* (atypical forms)
- A. Spores normally 45–100 μ long.
 - D. Spores 0–5-septate, clavate-cylindrical 3. *T. Farlowi*
 - D. Spores 7-septate.
 - E. Spores 55–73 μ long, clavate.... 4. *T. Rehmianum*
 - E. Spores 75–100 μ long, clavate-cylindrical..... 5. *T. Walteri*

The North American material designated in the key as *T. Rehmianum* was later described by Durand (3) under the new name *T. confusum* Durand, examination of the type specimen of

Geoglossum Rehmianum having revealed that species to be distinct.

In the present paper we are concerned only with the first primary subdivision of the key, containing the long-spored species, *i.e.* those with spores 100–170 μ in length. The species which we are presenting here as new falls in this group. It will be noted that Durand includes in the section besides *T. velutipes* and *T. hirsutum* certain atypical forms of the latter species which correspond with *T. velutipes* in that the spores are less than 15-septate. In fact, he recognizes in *T. hirsutum* besides the typical material two distinct forms, one *f. variabile* Durand with spores 80–150 μ long and 8–14 (most 11–14)-septate, the other *f. Wrightii* Durand with spores 110–140 μ long and 8- or 9-septate. He says that the spores of *T. velutipes* are "broader and stouter than those of the typical *T. hirsutum*," and his measurements indicate that in *T. velutipes* the asci are somewhat shorter. In discussing *f. Wrightii* he says: "The spores are stouter than in other forms of *T. hirsutum*. In fact, they exactly duplicate those of *T. velutipes*, but there are 8 spores in the ascus instead of four as in that species." Later, having examined additional material from Bermuda, Durand (3) raised this form to specific rank and named it *T. Wrightii* Durand. In this connection he says, "the spores resemble those of *T. velutipes* but there are 8 in each ascus."

Durand made no further contribution to the genus and died in 1922. His manuscript notes have been available to the writers, but careful examination of these has brought to light no information of significance not incorporated in his publications. Inasmuch as all of his specimens and microscopic preparations have been at our disposal it has seemed desirable that these also be examined with a view to determining whether there exist characters of value in separating species in this genus which were disregarded by him. The specimens in his herbarium show that in form and size the individual ascomata of a given species vary as much among themselves as those of different species do from each other. While *T. Wrightii*¹ seems to constitute an

¹ Through the courtesy of Professor H. H. Whetzel specimens of the Geoglossaceae collected in Bermuda by Whetzel, Seaver, and Ogilvie have

exception to this it is represented in his herbarium only by fragments.

In the microscopic study of Durand's material spore shape and size have been given particular attention. It was hoped that these characters might have at least supplementary value in the separation of species. Critical examination of spores of *T. velutipes*, *T. Wrightii*, and *T. hirsutum* has revealed certain minor differences in shape. These, while slight, are constant enough to afford an aid in determination. However, since they are not sufficiently pronounced to provide a practical basis for separation, the characters used by Durand must still be used. These permit a division of the long-spored forms into two groups. The first consists of *T. velutipes* and *T. Wrightii*, both with spores 8-11-septate. The second contains *T. hirsutum* and its form *T. hirsutum* f. *variabile*, which have spores 8-15 (mostly 11-15)-septate.

In the first group *T. Wrightii* seems not to be, as Durand thought, essentially an 8-spored *T. velutipes*, for the spores of the two are easily separable on the basis of shape. Those of *T. Wrightii* are pointed at the upper end, the tapering portion being almost straight and confined to the terminal two cells, the apical portion of the spore resembling somewhat the sharpened end of a pencil (FIG. 4). The spores of *T. velutipes* are distinctly blunt at the upper end, and the tapering termination is curved (FIG. 2). In length and septation the spores of the two species are indistinguishable.

Durand states that the spores of *T. hirsutum* are normally 15-septate, and that in f. *variabile* the number of septa is less (8-14). In our examination of his material it was found that, while in *T. hirsutum* the spores are usually 15-septate, individuals occur in which the septation is often greater or less than fifteen. Examination of immature spores shows that the normal septation

has been made available for examination. These contain numerous rich collections of *T. Wrightii*. This species is said by Professor Whetzel to be the most common and abundant member of the family found on the Islands. In gross aspect it seems distinct from all other members of the genus. The ascoma is almost spatulate, being strikingly compressed, and the ascigerous portion is scarcely distinct from the stem, the whole plant usually tapering from near the apex to the base.

is the result of successive equal divisions of the spore. The first septum forms in the center, dividing the spore into two equal cells. A septum is then laid down in the center of each of these cells giving four equal cells and three septa. This process continues until 16 cells are separated by 15 septa. Septation begins when the spore has attained nearly its full length. Occasionally some cells fail to divide. This leaves the spore with less than 15 septa and a few abnormally long cells which indicate the places at which the failures have occurred. Sometimes a few cells divide after the usual divisions have been completed. The spore then has more than 15 septa and the points at which the extra divisions have occurred are apparent from the presence of abnormally short cells (see FIG. 3, *b* AND *c*). In some of Durand's collections (Nos. 333, 3098, 9620) spores with 16 to 20 septa were frequently observed.

In *T. velutipes*, *T. Wrightii*, and *T. hirsutum f. variabile* the method of septation seems to be fundamentally different. The first septum forms in the center of the lengthened spore, but following it four septa are formed, apparently simultaneously, dividing these two cells into three cells each and giving the spore 6 cells and 5 septa. All five of these septa are usually equally spaced, but sometimes certain of the resulting cells are longer than others. The next division which is the last (except occasionally in the case of *T. hirsutum f. variabile*) divides the 6 cells equally into 12 with 11 septa, this seeming to be the usual number just as 15 is normal for *T. hirsutum*. Sometimes one or more of the last divisions fail to take place, especially if the cells formed by the second division are unequal. Spores with 8, 9, or 10 septa instead of 11 thus result. The points at which septa have failed to form are consequently not always as apparent here as in *T. hirsutum* (see FIGS. 2 AND 4). In *T. hirsutum f. variabile* after the spore has become 11-septate extra divisions may occur giving the spore more than 11 septa though as yet no 15-septate spores have been observed (see FIG. 3*d*, *e*, AND *f*). It would be interesting to determine in stained material whether these two different types of septation are correlated with fundamentally different nuclear histories. It would seem that the absolute number of septa in the spore is

not of primary significance. Though 15-septate spores have not been observed in *T. hirsutum* f. *variabile* the discovery of such spores would not result in the merging of this form with the typical *T. hirsutum*. The two would still be separable in that the character of the septation is essentially different in the two cases. This fact has made it evident in the minds of the writers that f. *variabile* should be given specific rank, but they hesitate to take this step until a thorough cytologic investigation has confirmed their observations as to the difference in the development of septation. If these observations are confirmed, the species of *Trichoglossum* probably should be rearranged so that *T. hirsutum*, *T. confusum*, and *T. Walleri* will fall in one group having spores typically 7- and 15-septate, while *T. velutipes*, *T. Wrightii*, *T. hirsutum* f. *variabile* (raised to specific rank), and *T. Farlowi* will fall in a second group having spores typically 5- and 11-septate. A similar revision may also be desirable in related genera of the family.

In size and shape the spores of f. *variabile* are very similar to those of typical *T. hirsutum*. In both, the upper end of the spore is more pointed than in *T. velutipes*, and tapering takes place in both directions from near the center of the spore, the distinction between the two ends being in consequence less evident. This may have been the basis of Durand's opinion that "the spores of *T. velutipes* are broader and stouter than those of *T. hirsutum*." However, both in *T. hirsutum* and f. *variabile* atypical spores approach the spore shape of *T. velutipes*. Though typical spores are distinctive in these three forms it is not always possible to determine on the basis of spore shape alone the species to which an isolated spore belongs.

A single collection of *Trichoglossum*, made by the junior author at Labrador Lake near Apulia, New York, in 1924, has proved to be distinct from any of the forms discussed by Durand. The spores are normally 15-septate as in *T. hirsutum*, but the asci are constantly 4-spored. In spore shape the form resembles *T. hirsutum*. The collection is especially interesting in that it brings to light a form bearing a relationship to *T. hirsutum* similar to that of *T. velutipes* to *T. Wrightii*.

If the Geoglossaceae be considered from the standpoint of

phylogeny it seems probable that the type of spore septation constitutes a more ancient character than does the number of spores in the ascus. In *Trichoglossum* it seems to afford the most natural basis for the primary separation of the group of species comprising the genus.

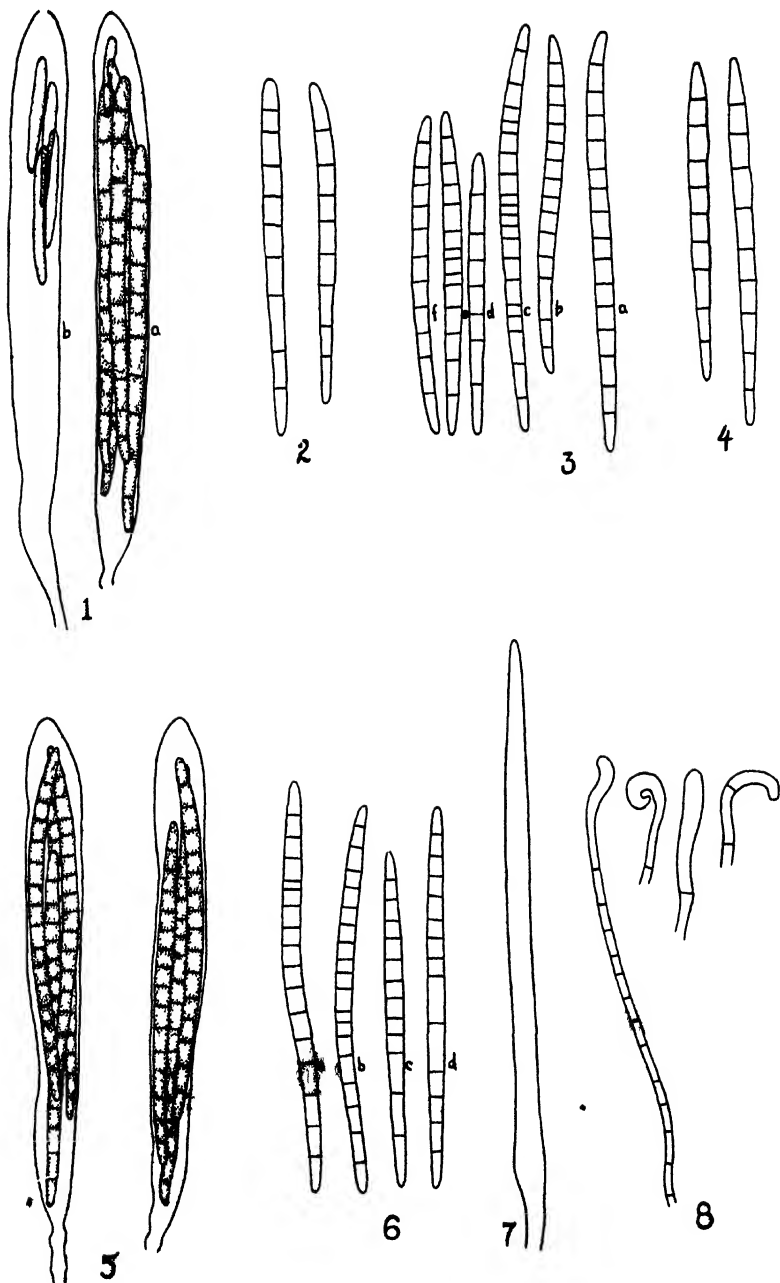
The new form then is to be regarded as most closely related to *T. hirsutum*. That it arose from this species or from a common ancestor with 8-spored asci is suggested by the fact that in it the young ascus contains the fundamentals of 8 spores. Four of these develop into spores. The other four elongate somewhat, but appear finally as no more than indistinct protoplasmic strands.

A similar condition exists in the other 4-spored species, *T. velutipes*. There, in certain collections (e.g. Durand Herbarium Nos. 1297 and 1521), the situation is exactly the same. In others (e.g. Durand Herbarium Nos. 788 and 1920) four short unicellular, yellowish spores with evident walls and contents are found at maturity accompanying the 4 long, brown, pluri-septate spores typical of the species (FIG. 1). In one collection (Durand Herbarium No. 807) the four small spores are hyaline and often uni-septate.

Following Durand's precedent in recognizing *T. velutipes* as distinct from *T. Wrightii* on the basis of the 4-spored nature of its asci it seems logical to consider the new form as a distinct species separable from *T. hirsutum* on the same basis. It also differs from *T. hirsutum* in having shorter asci. The shape of the spores and their 15-septate character separate it from *T. velutipes*. Though spores with a greater or less number of septa than 15 sometimes occur they correspond in their variation to the condition existing in *T. hirsutum* (FIG. 6). In both species spores with less than 15 septa are to be considered as abnormal. The collection of the new species comprises five ascomata. The following diagnosis is based on these.

***Trichoglossum tetrasporum* sp. nov.**

Ascomata black, 3-8 cm. high; ascigerous portion elliptical to sub-rotund, not more than 1/5 the total length of the entire ascoma, more or less compressed, rounded above, rather sharply delimited from the stem; stem terete, rather flexuous, 1-2 mm.



TRICHOGLOSSUM

thick, equal, black, velvety; asci clavate, apically narrowed, $175\text{--}220 \times 20\text{--}25 \mu$; spores 4 in a fascicle, brown, cylindrical-clavate, broadest above the middle, tapering each way to sub-obtuse ends, normally 15-septate at maturity, $110\text{--}160 \times 6\text{--}7 \mu$ (mostly $125\text{--}150$); paraphyses smoky brown, cylindrical, septate; tips somewhat curved, slightly thickened, 3μ thick below to 7μ thick above. Setae black, projecting slightly beyond the hymenium.

Labrador Lake near Apulia, New York. Fitzpatrick, 1924.

Type deposited in Plant Pathology Herbarium, Cornell University, Ithaca, N. Y., as No. 17779.

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EXPLANATION OF PLATE

The drawings were made by the senior writer. They were outlined with the aid of a camera lucida and reduced to one half their original diameter in reproduction. As reproduced the figures represent throughout a magnification of approximately 300 diameters.

Fig. 1. *Trichoglossum velutipes*. (a) Mature ascus containing four large, brown, pluriseptate spores accompanied by four smaller, yellowish unicellular spores, two of which are hidden from view. (b) Another ascus after dehiscence; the four smaller spores still in the ascus.

Fig. 2. *T. velutipes*. Typical spores.

Fig. 3. (a, b, c) *T. hirsutum*. (a) Normal 15-septate spore. (b) A 14-septate spore; the position of the missing septum evident. (c) A 19-septate spore; counting from the upper end the fourth, ninth, eleventh, and sixteenth septa are extra. (d, e, f) *T. hirsutum* f. *variabile*. (d) A 7-septate spore in which the two cells at each end have failed to undergo the final division. (e) A 13-septate spore in which an extra division has occurred in the two center cells. (f) An 11-septate spore, normal for the form.

Fig. 4. *T. Wrightii*. Typical spores.

Fig. 5. *T. tetrasporum*. Asci containing normal spores.

Fig. 6. *T. tetrasporum*. Atypical spores. (a, b) with extra septa, (c, d) with missing septa.

Fig. 7. *T. tetrasporum*. A cystidium (seta) taken from the ascigerous portion of the ascoma.

Fig. 8. *T. tetrasporum*. Showing variation in paraphyses.

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A NEW PORTO RICAN SPECIES OF ACREMONIELLA

RAFFAELE CIFERRI AND BAILEY K. ASHFORD

(WITH 2 TEXT FIGURES)

ORIGIN OF STRAIN: A saprophyte of the human skin.

COLLECTION NUMBER: 1557² Ashford.

CULTURAL AND MORPHOLOGICAL CHARACTERISTICS: Cultivated in favorable media, such as Sabouraud's proof-agar, the growth at laboratory temperature, 26° to 34° C., is quite rapid. The colony is white or whitish, at the beginning composed of creeping hyphae which extend superficially giving the appearance of an irregular cobweb. The surface, however, is not uniform but presents here and there some cottony mycelial tufts of the same color.

After four or five days when the colony has extended all over the surface of the agar, there are formed in the upper layer of the medium a series of dark olive areas, which run from dark to lighter shades, which are irregular, and which give to the whole colony a gray color which is not uniform.

As it increases in age the colony takes on a deeper color from a greater predominance of the olive-tint of the surface and on account of a less regular distribution of the white or whitish sterile hyphae on the surface (FIG. 1).

These morphological characteristics are constantly sustained in the various culture media tested, only varying in the thickness of the superficial white duvet which can pass from an almost compact cottony or ~~thick~~ wooly appearance to a cobweb consistence, with scanty and almost isolated superficial hyphae. The same can be said of the color of the duvet, at-first pure white and later often becoming whitish-gray to gray, or even deepening to an ochraceous tint. The characteristics of the blackish-green coat on the surface of the agar, however, do not vary. Even the substratum of the culture, here and there, has a dark tinge.

The morphology of this fungus is relatively simple: up to the

third day after inoculation of the media there are no fructifications, the hyphae consisting of two types. The deeper hyphae, completely serpentine, are subhyaline, very frequently septate and normally narrowed at the site of the septa. Generally the septa are very close together and the narrowing above-mentioned gives to the hypha a toruloid appearance, although it is very



FIG. 1. Colony of *Acremonia olivacea*, on Sabouraud's proof agar ten days old. $\frac{3}{4}$ natural size.

irregular (FIG. 2, *b*). Generally the protoplasm cannot be recognized by the eye and the membranes are thick and clearly distinguished. The caliber of these hyphae, although very variable, normally reaches a size three or four times that of the aerial hyphae (15 or more microns). These last, which are more superficial and form the cottony and cobweb duvet, sprout from the first variety in the substratum of which they are generally lateral branches. They are sub-erect, less frequently septate than the first form and of a lighter color. In fact, they are almost hyaline with a more delicate external membrane and generally a more brilliant protoplasm. The hyphae are more abundantly branched but they have no characteristics that are worthy of special mention. Their caliber, although variable, oscillates between 3 and 5 microns and, the most delicate, between 1.0 and 2.0 (FIG. 2, *a*).

From these sterile hyphae are derived some short fertile ones, which are generally lateral, simple, always creeping, usually curved and rarely straight, subhyaline, and function as conidiophores. These conidiophores have approximately the same caliber as the hyphae from which they spring (1.0 to 3.0 microns).



FIG. 2. *Acremonialla olivaceospora*, nova sp. (a) Conidia, conidiophores, and hyphae, (b) Deep hyphae (c) Beginning of the formation of conidia (d), Isolated conidia, (e) Germinating conidia, (f) Insertion of conidia on the conidiophores. Sketched from camera lucida, object. 4, ocular 25, B. and L. except a part of (c) sketched with ocular 10.

The length is very variable, however, oscillating between 20 and 30 microns or more, but they can be so short that they simulate sessile conidia, that is to say, they may spring apparently directly from the primary hyphae (FIG. 2, *a*). All these short hyphae are fertile and each one produces a conidium which is entirely acrogenous and solitary. At the free extremity of the conidiophore a more or less spherical head is formed, subhyaline at first, but almost immediately becoming dark and finally black and opaque, as it approaches its ultimate size (FIG. 2, *f*). The insertion of the conidiophores on a sterile hypha, and their number and disposition, is very variable. Normally the conidiophores are well separated the one from the other in a sterile hypha, but frequently they become much more approximated, although they never spring from the same point, as in some cases it may appear at first sight. There are occasions where a hypha which is giving birth to conidiophores may itself bear at its termination a spore; or a hypha of this category may terminate in a fork each branch of which may bear a conidium; or there may be even a double branched terminal in which one branch may carry a conidium and the other may continue as a mycelial element.

The conidiophore fails to present anything worthy of special mention either at the base or the tip; nevertheless, the tip may be slightly swollen although never really spherical.

The appearance of a fertile hypha with its conidiophores and conidia hanging therefrom, black and opaque, reminds one a good deal of a branch of an olive-tree with ripe, black olives. On account of this similarity the name of the species has been given (Fig. 2, *a*).

The conidia, usually apical and solitary, may be double and, on extremely rare occasions, triple. These last exceptions are, evidently, abnormalities due to the exceptional conditions which the medium may offer. On direct observation of a culture in a Petri dish, groups of conidia seem to be very frequent, but in reality this disposition is purely an illusion and is due to overlaying of several fructifying conidiophores, each on a different plane (FIG. 2, *c*). The conidia do not easily separate from the conidiophore as a rule, even when they are completely mature;

in our studies of development we have frequently seen the conidium germinate while still attached to its conidiophore.

The conidia are quite polymorphous (FIG. 2, *d*); however, the dominant form varies between spherical and elliptical if one looks at them from the front. Laterally, the shape frequently appears asymmetrical, that is to say, with one side convex and the other flat or concave. The color is absolutely dead-black, carbonaceous, and opaque, so it is impossible to distinguish the episporium. The size is from 15 to 26 microns or 10 to 18.5 \times 14 to 26 microns, the average size falling between 18 and 22 microns.

The conidia germinate with considerable difficulty in hanging drop and frequently even while they are hanging from a conidiophore. They form one or, rarely, more germinative tubes which lengthen indefinitely, branching repeatedly and irregularly without being able to produce anything but mycelium (FIG. 2, *e*).

SYSTEMATIC POSITION

This fungus from its black spores and sub-hyaline, at times smoky, hyphae, with solitary and apical conidia, should be placed among the Dematiaceae Macronemeae Monotosporeae, and from its abundant sterile hyphae in the genus *Acremoniella* Saccardo (3, page 302). This genus has its corresponding prototype among the Moniliaceae in the genus *Acremonium* Link. If we consider the genus *Acremoniella* as defined in its original sense, our strain can be easily included therein. As a matter of fact, as far as the conidiophores are concerned, Saccardo writes " . . . ramulos sporigeros simplices breviusculos hinc inde exserentes . . . " without defining whether the conidiophores are erect or prostrate. On the contrary, Ferraris (1, page 268) writes: "conidiophora erecta . . . " while Lindau (2, page 675) affirms almost literally the generic diagnosis of Saccardo. If we accept the genus *Acremoniella* with the addition, rather than the amendment of Ferraris, our strain, which has conidiophores that are always beyond question prostrate, could not be included strictly among the *Acremoniella*, while if we accept the first definition the contrary would be the case. In reality the addition of Ferraris can be justified by informing ourselves of

the type species of *Acremoniella*, *A. atra* (Corda) Sacc., which has, according to the Sylloge Fungorum, "conidiophores assurgentes." But this is not so or this characteristic is not expressed in the other six species and one variety of the Sylloge, and also in two of the three species registered among the flora of Ferraris.

We believe, therefore, that it would be better to return to the original signification of Saccardo's genus and add to the diagnosis: conidiophores erect or prostrate, dividing *Acremoniella* into two subgenera, **Eu-Acremoniella** *nobis*, with conidiophores erect, and **Acremoniellopsis** *nobis*, with prostrate conidiophores. Our species should therefore be placed in this subgenus where they will be alone, as we have no information as yet that others should join them. However, it is not impossible that a comparative study of the species of *Acremoniella* in culture, under different conditions and media, might modify to an extent the subdivision of the genus or cause a redistribution of the species among the two subgenera.

Therefore we present the following new species:

***Acremoniella* (*Acremoniellopsis*) *olivaespora* Ciferri & Ashford,**
sp. nov.

Grayish-white colony, from the texture of a cobweb to cottony, afterward of a dull olive-brown color; old sterile smoky hyphae, of heavy caliber (15 mic. or over), highly septate and almost moniliform, prostrate; young hyphae sub-hyaline, highly branched, with a diameter of from 1.0 to 5.0 microns, sub-erect; short conidiophores (30 or more microns), lateral, simple and prostrate, of uniform caliber (1.0 to 3.0 microns), never branched, monosporous; conidia continuous, solitary, or rarely double or triple in a group, apical, spherical to elliptical, in profile hemispherical or semilunar, dissymmetrical or not, not easily dislodged, black, carbonaceous or opaque, 12 to 18 by 14 to 26 microns or 15 to 26 microns in diameter, generally 18 to 22, which germinate by producing one or rarely two germinative tubes, even without separating from the conidiophores.

Habitat: The human skin, San Juan, Porto Rico (legit. Bailey K. Ashford, September, 1928).

SUMMARY

A study was made of a new species of the genus *Acremoniella* (*A. olivaezpora*) and some observations were made on this genus which was divided into two subgenera.

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NEW SPECIES OF LICHENS FROM PORTO RICO. III.¹

A. ZAHLBRUCKNER

[As stated in the first paper of this series, 110 specimens of the Porto Rican lichens were submitted to Doctor Zahlbruckner for study. The new species described below are the result of his work on these specimens.]

1. *Thelidium leucoplacum* Zahlbr. (n. sp.)

Thallus epilithicus, tenuis, tartareus, late expansus, e maculis pluribus confluentibus formatus, griseo-albus, opacus, minute areolatus, areolis ad 0.1 mm. latis, planis, angulosis, rimis tenuissimis separatis, soridiis et isidiis nullis, in margine passim linea tenui nigra cinctus; gonidia ad *Cystococcum* pertinentia. Apothecia plus minus dispersa, adpresso-sessilia, minuta, 0.1–0.15 mm. lata, nigra, opaca, a thallo libera, convexa; excipulum dimidiatum, fusco-nigrum, ostiolo minuto pertusum; hymenium gelatinosum, J dilute cupreum; paraphyses mox confluentes; asci ovali-clavati, 8 spori; sporae in ascis biseriales, decolores, ellipsoideae vel ovaes, rectae, uniseptatae, septo tenui, 14–18 \times 8–9 mic.

On rocks on an open hill-side near Yauco, Fink 1399.

2. *Microthelia socialis* Zahlbr. (n. sp.)

Thallus endophloeodes, extus macula roseo-albido, nitidulo indicatus, late expansus, laevigatus, continuus vel hinc inde irregulariter fissus, sorediis et isidiis nullis, in margine linea tenui umbroso cinctus; gonidia ad *Trentepohliam* pertinent. Apothecia minuta, 0.15–0.2 mm. lata, adpresso-sessilia, convexa, primum leviter velata, mox nuda, nigra, nitida, rare dispersa, ut plurimum seriatim disposita vel aggregata, poro terminali, vix conspicuo; excipulum fusco-nigrum vel obscurè fuscum, haud fragile, dimidiatum; hymenium decolor, J lutescens; paraphyses crebrae, ramosae et intricatae; asci late obpyriformes, ad apicem rotundato-retusati et membrana bene incrassata cincti, 8 spori;

¹ No. II of this series was published by E. A. Vainio in *MYCOLOGIA* 21: 33–40. 1929. The present was transmitted through the Botany Department of Miami University, Oxford, Ohio, by Joyce Hedrick.

spora in ascis bi-triseriales, olivaceo-fuscae, oblongo-ellipsoideae, rectae, uniseptatae, cellula superiore parum brevior et latior, septo tenui, ad septum leviter constrictae, $15-17 \times 6$ mic.

On trees on an exposed hill-top near Yauco, Fink 1459a.

3. *Pyrenula psoriformis* Zahlbr. (n. sp.)

Thallus epiphloeodes, crustaceus, tenuis, alutaceo-fuscus vel fuscus, passim alutaceus, nitidus, areolatus, areolis polygonis, 0.2–0.6 mm. latis, plus minus convexis, fissuris tenuibus separatis vel hinc inde, imprimis ambitum thalli versus, subsquamulosis, superne minute granulosi et lineis latiusculis, nigris, irregularibus sat dense percursis; gonidia ad Trentepohliam pertinentia. Apothecia sessilia, nigra, nitida, convexa, ad 1 mm. lata, ad basin leviter abrupta vel passim sensim in thallum angustata, poro terminali, leviter impresso pertusa; excipulum extus a thallo chondroideo, crassiusculo, ad ambitum nigro, intus decolores vel rufescente, ex hyphis intricatis et gelatinose conglutinis formato, in parte basali gonidia chroolepoidea includente obductum, fuliginum, integrum, extrorsum versus ad basin breviter acutato-elongatum; hymenium decolor, purum, J lutescens; paraphyses filiformes, simplices, sat liberae; asci cylindrico-clavati, ad apicem rotundati, 8 spori; spora in ascis uniseriales, fuscae (primum fumosae), oblongo-ellipsoideae, rectae, 4 loculares, loculis late lentiformibus, fere aequalibus, $12-16 \times 5-6$ mic.

On trees in woods near Yauco, Fink 1449.

4. *Anthracotheccium maculare* Zahlbr. (n. sp.)

Thallus epiphloeodes, maculas rotundatas, bene limitatas formans dispersas vel hinc inde confluentes, crassiusculus, usque ad 1 mm. altus, ochraceo-isabellinus, nitidus, KHO plus CaCl_2O_2 aurantiacus, laevigatus et continuus, leviter inaequalis, sorediis et isidiis nullis, in margine linea obscuriore non cinctus; gonidia ad Trentepohliam pertinentia; medulla dilute flavens. Apothecia thallo immersa, parva, ad 0.3 mm. lata, tantum vertice nigro, ad 1.5 mm. lato et convexulo prominula, demum elabentia et foveolas nigricantes relinquentia; excipulum globosum, integrum, fuliginum, tenue, hymenium decolor, non inspersus, J lutescens; paraphyses filiformes, simplices vel partim ramosae, e septatae; asci ovali-clavati, mox diffuentes, 8 spori; spora in ascis triseriales, e fumoso demum rufescentifuscae, ellipsoidea, rectae, murales, cellulis in seriebus superpositis 8, in seriebus horizontalibus 1–3, $34-45 \times 14-16$ mic. Affinis est *A. mucoso* (Vainio) sed apothecia minora, spora non monostichae et thallus aliter coloratus.

On shrubs on an exposed hill-top near Yauco, Fink 1578.

5. *Dermatina Finkii* Zahlbr. (n. sp.)

Thallus pro maxima parte epiphloeodes, maculosus, isabellinus, opacus, KHO luteus, demum aurantiaco-sordidescens, inaequalis, subverruculosus vel passim sublaevigatus, isidiis et sorediis non praeditus, in margine linea obscuriore non cinctus, fere homoeomericus; gonidiis cystococcoideis, globosis, laete viridibus, 9–10 mic. latis; hyphae thalli non amyloideae. Apothecia sessilia, nigra, opaca, rotundata vel irregularia, rarius oblonga, 0.4–1 mm. longa, modice convexa, immarginata; excipulum crassiusculum, integrum, fuliginum, e basi columellas varie longas, hymenio parum breviores vel hymenium omnino percurrentes emittens; hymenium purum, J lutescens; paraphyses ramosae et intricatae, parum distincte limitatae; asci late ellipsoidei, 8 spori; sporae in ascis biseriales, decolores, ellipsoideae, utrinque rotundati, in medio constrictae, murales, cellulis subcubicis, leptodermaticis, in seriebus superpositis 8, in seriebus horizontalibus 1–4, halone non cinctae, $31\text{--}39 \times 12\text{--}17$ mic.

On posts in an open field near Aibonito, Fink 2015.

6. *Diploschistes stramineus* Zahlbr. (n. sp.)

Thallus tenuis, substrato arcte adnatus, subtartareus, pallide stramineus vel ochraceo-albidus, opacus, KHO- vel dilutius flavescens, CaCl_2O_2 -, primum continuus, demum irregulariter et passim grosse subareolatim fissus, fissuris tenuibus, superne inaequalis, sorediis et isidiis nullis; medulla alba, KHO-, CaCl_2O_2 rosacea, J rufescenti-violacea. Apothecia adpresso-sessilia, dispersa vel approximata, rotunda, ad basin retusae vel leviter constricta, usque 1 mm. lata; discus e concaviusculo planus, niger, glaucescenti-pruinosis, a vertica excipuli tenui, nigro et integri circumdatus; margo thallinus sat angustus, subinteger, discum non vel vix superans; excipulum fusco-nigrum, integrum, modice incrassatum, extus a thallo vestitum; hymenium 125–140 mic. altum, superne fuscum et pulverulentum, caeterum fere decolor, J lutescens; paraphyses simplices, filiformes, septatae, ad apicem non clavatae; asci variaeformes, subcylindrici, oblongi vel ovals, 6–8 spori; sporae in ascis subuniseriales, olivaceae vel fuscae, ovals, in uno apice rotundatae, in altero apice plus minus attentuatae, murales, septis horizontalibus 5, verticalibus 1–2, $24\text{--}26 \times 8\text{--}10$ mic.

On clay banks along an open roadside near Mayaguez, Fink 1008 and 1016.

7. *Calenia albonigra* Zahlbr. (n. sp.)

Thallus epiphyllus, maculas irregulares, plus minus confluentes, mediocres formans, substratum arcte obducens, glaucescenti-

albidus, opacus KHO et CaCl_2O_2 non mutatus, continuus, in ambitum in plagas minores et dispersas dissolutus, laevigatus, sorediis et isidiis non instructus, in margine linea obscuriore non cinctus, fere homoemicus, gonidiis cystococcoideis, late viridibus; hyphae thalli non amyloideae. Apothecia minuta, ad 0.2 mm. lata, lecanorina, sessilia, rotunda, ad basin non angustata, plus minus dispersa; discus angustus, niger, haud nitens, demum convexiusculusi margo thallinus discum annulatim cingens, albus, integer, demum plus minus depressus; hymenium superne dilute umbrinum vel subcinnamomeum, non inspersum, caeterum vitreo-pellucidum, purum, J coerulum (imprimis asci), strato gonidiali non superpositum; paraphyses gelatinose conglutinatae, parum distinctae, ramosae, eseptatae, non clavatae; asci oblongi vel ellipsoideo-clavati, superne rotundati et membrana bene incrassata cincti, 8 spori; sporae in ascis biseriales, oblongae vel ellipsoideo-oblongae, utrinque rotundatae, rectae vel subrectae, uniseptatae, septo tenui, ad septum non constrictae, membrana tenui cinctae, $7.5-8.5 \times 3$ mic.

On leaves near Manati, Fink 2121.

8. *Gyalecta* (sect. *Secoliga*) *rubella* Zahlbr. (n. sp.)

Thallus epilithicus, tenuis, substratum arcte obducens, sub-tartareus, virenti-argillaceus, fere opacus, tenuissime diffractus, in margine linea obscuriore non cinctus, sorediis et isidiis destitutus; gonidia ad Trentepohliam pertinentia, cellulis ovalibus vel rotundatis, membrana ad 5 mic. crassa cinctus. Apothecia habitu biatorina, sessilia, ad basin leviter constricta, passim sat crebra, parva, 0.3-0.7 mm. lata, carneo-rufescentia, madefacta laetius colorata, opaca, concaviuscula vel plana; margo thallinus tenuis, integer, demum depressus; excipulum dimidiatum, lutescenti-fuscescens, subchondroideum; hymenium sat angustum, 78-88 mic. altum, superne anguste umbrino-obscuratum, caeterum decolor et purum, J coeruleo-sordidum; paraphyses filiformes, simplices, eseptatae, ad apicem non clavatae, conglutinatae; asci oblongi-clavati, ad apicem bene rotundati vel subretusati, recti vel curvulae, 8 spori; sporae in ascis 2-3 seriales, decolores, subdactyloideo- vel subfusiformi-ellipsoideae, rectae vel curvulae, utrinque acutatae vel in uno apice paulum latiores, 6 loculares, septis tenuibus, membrana tenui cinctae, $17-20 \times 5$ mic.

On rocks in a shady field near Naranjito, Fink 185.

9. *Pyrenopsis portoricensis* Zahlbr. (n. sp.)

Thallus epilithicus, expansas, tenuis, uniformis, fusco-niger, opacus, siccus minute areolatus, madefactus magis continuus et

sub-byssaceo-inaequalis, in margine haud bene limitatus, sorediis et isidiis nullis, fere homoeomericus, gonidiis glaucescentibus, vagina purpurascente, KHO violascente, cinctus. Apothecia dispersa vel approximata, ex innato sessilia, minuta, usque 0.5 mm. lata, vulgo tamen minora, nigra, convexula, margine vix conspicuo; hymenium superne anguste olivascens, non in-spersum, caeterum decolor, purum, pellucidum, 95–100 mic. altum, J aeruginosa-sordidescens; paraphyses capillares, conglutinatae, sed distincte limitatae, simplices, eseptatae, non clavatae; asci ovali-clavati vel obpyriformis, ad apicem rotundati et membrana incrassata cincti, 8 spori; sporae in ascis 2–3 seriales, decolores, simplices, ellipsoideae, rectae, membrana tenui obductae, $9-10 \times 3-3.5$ mic.

On rocks in open fields near Rio Grande, Fink 690; Mayaguez, Fink 1257, 1278; and Aibonito, Fink 1950.

10. *Psorotichia calcigena* Zahlbr. (n. sp.)

Thallus endolithicus, extus macula sat expansa, albida vel sordide cinerascens, opaca indicatus, continuus, in margine linea distincta non cinctus, plectenchymaticus, ex hyphis densis, leptodermaticis formata; stratum gonidiale in parte superiore thalli situm, e glomerulis approximatis gonidiorum formatum, continuum, cellulae gonidiorum 2–4–(8) in gelatina communi immersae, dilute coerulescenti-glauescentes, 5–6 mic. latae; gelatina in parte marginali thalli fuscescens. Apothecia crebra, dispersa vel parum approximata, sessilia, nigra, opaca, minuta, circa 0.5 mm. lata, urceolata vel concava, margine proprio integro, prominulo et crassiusculo cincta; excipulum dimidiatum, rufescenti-fuscum; hypothecium obscure rufo-fuscum, crassiusculum; hymenium superne rufescenti-fuscescens, caeterum dilute fuscescens, purum, 75–80 mic. altum, J dilute coerulescens et demum lutescenti-fuscescens; paraphyses filiformes, simplices, eseptatae, ad apicem parum latiores, gelatinose conglutinatae; asci oblongo-ellipsoidei, inferne angustati, 8 spori; sporae in ascis biseriales, decolores, simplices, oblongo-ellipsoideae, utrinque rotundatae vel modice angustatae, rectae, membrana per-tenui cinctae, $10-11 \times 5-6$ mic., contentu inaequali.

On rocks in an open field near Yauco, Fink 1413.

11. *Thyrea myriocarpa* Zahlbr. (n. sp.)

Thallus monophyllus, squamosus, squamis umbilicatis, dispersis vel approximatis, rotundis vel rotundatis, 2–4 mm. latis, planis vel planiusculis, superne modice inaequalibus, in margine subintegris vel minute crenulatis, ad ambitum passim leviter

elevatis, nigris, opacis, madefactis aeruginoso-nigricantibus, epruinosis, subtus nigris, increbre verruculosus, homoeomericus, ex hyphis laxiusculis, tenuibus, reticulatim-ramosis, distincte non septatis et ex gonidiis ad *Xanthocapsam* pertinentibus, ad ambitum thalli membrana ochraceo-fuscescente cinctis formatus, cellulae gonidiorum aeruginosae, usque 18 mic. latae. Apothecia lecanorina, numerosa in quavi squama thalli, valde minuta 0.06–0.1 mm. lata, semiimmersa; discus obscure fuscus, opacus, non pruinosus; margo thallinus crassiusculus, primum supra discum connivens, demum modice divergens; excipulum parum distinctum, in apotheciis juvenilibus integrum, decolor; hypothecium angustum, decolor; hymenium superne ochraceo-fuscescens, non inspersum, caeterum decolor et purum; paraphyses strictiusculae, capillari-filiformes, eseptatae, simplices vel parce ramosae, non capitatae; asci oblongo-clavati, 8 spori; sporae decolores, simplices, ovaes, bene evolutae non visae.

On rocks in an open field near Manati, Fink 2053.

12. *Leprocollema Finkii* Zahlbr. (n. sp.)

Thallus epilithicus, crustaceus, uniformis, tenuis, usque 1 mm. crassus, siccus olivaceo-nigrescens vel olivaceo-aeruginosus, opacus, subverruculoso-areolatis, areolis 0.2–0.4 mm. latis, convexulis vel planiusculis, primum dispersis, demum confluentibus, hypothallus distinctus non evolutus, homoeomericus, gonidiis nostocaceis, glomeratis (glomerulis rotundis), copiosis, hyphis increbris circumdati. Apothecia primum immersa, demum adpresso-sessilia, biatorina, dispersa, rotunda, usque 1 mm. lata, primum leviter urceolata, demum concaviuscula; margo proprius prominulus, integer, obtusiusculus, demum angustatus, disco concolor vel demum parum pallidior; discus rufescenti-fuscescens, opacus, epruinosis; hypothecium lutescens, molle, ex hyphis intricis formatum; hymenium superne anguste rufescens, caeterum decolor et purum, 100–120 mic. altum, J e coeruleo cupreo-rufescens; paraphyses capillares, conglomeratae, simplices, eseptatae, non clavatae; asci clavati vel oblongo-clavati, plerumque curvuli, superne rotundati, 8 spori; sporae in ascis uni-vel biseriales, decolores, simplices, ellipsoideae vel ovali-ellipsoideae, utrinque rotundatae, rectae, membrana tenui cinctae, primum guttula oleosa unica et majuscula impletae, 18–20 \times 8–9 mic.

On rocks on an exposed hill-top near Yauco, Fink 1385, 1396; and near Rio Piedras, Fink 616.

13. *Lecidea* (sect. *Biatora*) *camporum* Zahlbr. (n. sp.)

Thallus epilithicus, tenuis, subtartareus, substratum arcte obducens, alutaceo-sordidus, opacus, KHO parum lutescens,

CaCl_2O_2 non tinctus, sorediis et isidiis destitutus; medulla tenuis, alba, ex hyphis non amylaceis formata; gonidia cystococcoidea, 9–11 mic. lata, glomerata. Apothecia plus minus dispersa vel passim confluentia, sessilia, rotunda, parva, 0.4–0.8 mm. lata, livido-fusca vel nigricantia, opaca, convexa, margine jam in juventute depresso; excipulum dimidiatum, fusco-nigricans, ex hyphis tenuibus, subradiantibus formatum; hymenium 65–75 mic. altum, pallide sordidum, superne parum obscurius, J e coeruleo aeruginoso-obscuratum; hypothecium crassiusculum, obscure fuscum vel fere nigricans, ab hymenio non distincte limitatum; paraphyses filiformes, simplices, eseptatae, non clavatae, conglutinatae; asci ellipsoideo-clavati, superne rotundati, recti, 8 spori; sporae in ascis plus minus biseriales, simplices, decolores, ellipsoideae vel ovali-ellipsoideae, rectae, membrana tenui cinctae, $7\text{--}7.5 \times 4$ mic.

On rocks in an open field near Yauco, Fink 1677.

14. *Lecidea* (sect. *Biatora*) *piperis* (Sprgl.) Nyl. *saxigena* Zahlbr. (n. var.)

Thallus argillaceus, opacus KHO vix mutatus, continuus, passim laevigatus, passim inaequalis vel subplicatus, sorediis et isidiis nullis; medulla coccinea vel passim albida, J viololascens. Apothecia sessilia, dispersa, approximata vel hinc inde seriata, ad basin constricta, 0.7–0.8 mm. lata, e plano convexiuscula, carneo-argillacea, opaca; margo proprius integer, madefactus nigricans, latiusculus, discum haud superans, extus strato rubicundo chondroideo, discum parum superante obductus, intus coccineo-kermesinus, J violascens, ex hyphis tenuibus, radiantibus, conglutinis formatus; excipulum integrum, fusco-nigrum, infra hymenium paulum crassius, usque ad verticem hymenii assurgens; hymenium decolor, pellucidum, purum, 75–80 mic. altum, superne fere decolor; paraphyses filiformes, strictae, ad 2 mic. crassae, conglutinatae, simplices, eseptatae, non clavatae; asci ellipsoideo-clavati, inferne breviter pedicillati, 8 spori; sporae in ascis biseriales vel subuniseriales, decolores, simplices, ellipsoideae vel sublongae, utrinque aequaliter rotundatae, rectae, membrana tenui cinctae, $12.5\text{--}14 \times 7\text{--}7.5$ mic.

On rocks in a shady field near Naranjito, Fink 191.

15. *Lecidea* (sect. *Biatora*) *mayaguez* Zahlbr. (n. sp.)

Thallus crustaceus, uniformis, tartareus, tenuis maculas dispersas vel confluentes formans, stramineo-albidus vel passim dilute ferrugineus, opacus, KHO-, CaCl_2O_2 -, KHO plus CaCl_2O_2 aurantiacus, granuloso- vel verruculoso-inaequalis, demum sub-

leprosus, sorediis et isidiis nullis, in margine linea obscuriore non cinctus; gonidia palmellaceae, dilute viridia, 7–8 mic. lata, glomerata; medulla alba. Apothecia biatorina, sessilia, dispersa, rotunda vel subirregularis, obscure rufo-fusca, opaca, primum urceolata, mox convexa et plus minus gibberulosa, margine mox depresso, integro; excipulum dimidiatum, fusco-fuliginum, KHO in rufescentem vergens; hymenium 200–210 mic. altum, superne anguste fuscum et tenuiter inspersum, caeterum fuscens, KHO magis lutescens, passim fere decolor, purum, J e violaceo aeruginoso-fuscum; paraphyses capillares, strictae, conglutinatae, simplices, eseptatae, non clavatae; hypothecium pallide fuscum vel expallescent; asci hymenio subaequilong, clavati, subrecti vel curvuli, superne rotundati et membrana bene incrassata cincti, 8 spori; sporae in ascis plus minus biseriales, decolores, simplices, ellipsoideae vel subovales, utrinque angustato-rotundatae, rectae, membrana tenui obductae, guttulis pluribus et parvis impletae, $15\text{--}17 \times 5\text{--}7.5$ mic.

On rocks in the open near Mayaguez, Fink 1100.

16. *Lecidea* (sect. *Biatora*) *portoricana* Zahlbr. (n. sp.)

Thallus epilithicus, crustaceus, uniformis, tenuis, substratum arcte obducens, isabellinus, opacus, KHO aurantiacus, CaCl_2O_2 -, continuus, parum inaequalis, sorediis et isidiis nullis, in margine bene limitatus, sed linea obscuriore non cinctus; medulla alba, hyphis non amyloideis; gonidia cystococcoidea. Apothecia biatorina, sessilia, rotunda, convexa, ad basin leviter constricta, dispersa, usque 1 mm. lata, hymenio demum elabente cupulam pallidam relinquentia; margo tenui discum modice superans, niger, integer vel subinteger; discus livido-rufescens, demum nigricans, concavus, epruinus; excipulum ad latera hymenii ex hyphis dense conglutinis, filiformibus et radiantibus formatum, ad verticem parum nigrescent, caeterum cinereum, dense inspersum, ad margine tenuiter fuscens; hypothecium crassum, fuscens; hymenium superne non inspersum, tenuiter olivaceo-fuscens, caeterum decolor et purum, 75–80 mic. altum, J aeruginoso-coerulescent; paraphyses filiformes, simplices, eseptatae, haud capitatae, conglutinatae; asci ellipsoideo-clavati, ad basin breviter pedicellati, superne rotundati, et membrana bene incrassata cincti, 8 spori; sporae in ascis biseriales vel subbiseriales, decolores, simplices, ellipsoideo-oblongae, utrinque rotundatae, rectae, rare curvulae, membrana tenui cinctae, $10\text{--}12 \times 2.8\text{--}3$ mic.

On rocks in the open near Naranjito, Fink 101.

17. Catillaria (sect. *Eucatillaria*) **pannosa** Zahlbr. (n. sp.)

Thallus epiphloeodes, late expansus, crassus, 1–1.6 mm. altus, alutaceo-sulphureus, opacus, KHO flavens, KHO plus CaCl_2O_2 subaurantiacus, omnino isidiso-leprosus, sorediis non praeditus, irregulariter areolato-rimosus vel areolatus, in margine linea obscuriore non cinctus; stratum corticale fere decolor, tenue, ad 30 mic. crassum, ex hyphis parum intricatis, subhorizontalibus formatum; medulla alba, KHO-, CaCl_2O_2 -; gonidia glomerata, glomerulis plus minus dispersis, cystococcoidea, 3–5 mic. lata. Apothecia lecideina, dispersa, 0.8–1.6 mm. lata, primum immersa, demum adpressa, thallum vix superantia, nigra, opaca, epruinosa, primum rotunda, margine tenui integro, non prominula cincta, demum subirregularia, fere arthonioidea, convexula et immarginata; excipulum violaceo-nigricans, KHO sordide purpureum, dimidiatum, infra hymenium modice inflexum, 60–70 mic. crassum, ex hyphis crassiusculis, leptodermaticis, radiantibus formatum, chondroideum; hypothecium crassum, nigricanti-violaceum; hymenium superne anguste nigricans, caeterum decolor vel passim violaceo-obscuratum, purum, 65–80 mic. altum, J cupreum; paraphyses filiformes, conglutinatae, simplices, ad apicem capitatae, eseptatae; asci oblongo-clavati, superne rotundati et membrana modice incrassata cincti, 8 spori; sporae in ascis biseriales, decolores, ellipsoideo-fusiformes, utrinque acutatae, rectae vel subrectae, biloculares, septo valde tenui, membrana tenui obvellatae, $14\text{--}16 \times 4\text{--}6$ mic.

On trees along an open roadside near Mayaguez, Fink 1097.

18. Bacidia (sect. *Eubacidia*) **microphialoides** Zahlbr. (n. sp.)

Thallus epilithicus, crustaceus, uniformis, tenuis, substratum arcte obducens, argillaceus vel sordidescens, opacus, reagentiis solitis non tinctus, continuus, laevigatus, sorediis et isidiis nullis, in margine linea obscuriore non cinctus; gonidia cystococcoidea. Apothecia minuta, 0.2–0.4 mm. lata, sessilia, rotunda, ad basin parum constricta, convexa, dispersa vel approximata, lutescenti-carnea, opaca, margo thallo concolor, siccus depressus, madefactus aquosus, obscuratus et paulum turgescens; excipulum integrum, decolor, ex hyphis radiantibus et conglutinatis, leviter intricatis, subindistincte septatis formatum; hymenium angustum, 37–40 mic. altum, superne valde anguste pallide umbrinum, caeterum decolor et purum, J e coeruleo cupreo-rufescens; paraphyses strictae, filiformes, conglutinatae, eseptatae, modice clavatae; hypothecium lutescens, molle; asci crebri, clavati, ad apicem rotundati, 8 spori; sporae in ascis 3–4 seriales, decolores, fusiformi-aciculares, subrectae, in uno apice rotundatae, in

altero angustatae, demum indistincta 8 locales, $24-27 \times 1.5-1.8$ mic.

On rocks in an open pasture near Mayaguez, Fink 1227.

19. *Ramalina Finkii* Zahlbr. (n. sp.)

Thallus erectus, pumilus, 12–20 mm. altus, caespites densos formans, molliusculus, ochraceo-glauescens vel subochraceus, opacus, KHO-, e basi increbre ramulosus, ramis applanatis, vulgo ad 2 mm. latis, demum hinc inde usque 4 mm. latis, ultimus linearibus, acutis, omnibus concavis vel subcanaliculatis et indistincte longitudinaliter nervosis, in superficie verruculis sorediosis, minutis, glaucescentibus increbre instructis; cortex angustus, fuscens, haud inspersus, continuus; fasciae axis chondroideae cortici accumbentes, distantes, in sectione transversali alte convexa, semi-circulares vel fere circulares; medulla alba, stippea, KHO-; gonidia cystococcoidea. Apothecia subterminalia, breviter et late pedicellata, 5–6 mm. lata, urceolata; discus rosaceus vel albidus, dense albopruinosus, concavus; margo subinteger; receptaculum extus foveolatum, marginibus foveolarum acutis; sporae oblongae, utrinque rotundatae, rectae vel subrectae, uniseptatae, $11-13 \times 4$ mic.

On trees and posts in open fields near Aibonito, Fink 1799, 1878.

20. *Usnea (Pachynea) Finkii* Zahlbr. (n. sp.)

Thallus elongatus, pendulus (in speciminibus visis usque 20 cm. longus), molliusculus, simplex vel rare ramo unice praeditus in parte superiore thalli affixo, rami primarii plus minus undulati, teretes, plures intricati, laeves, nudae, ochraceo-lutescentes, nitiduli, KHO flaventes, sorediis nullis, demum transversim fracti; rami secundarii sat densi, usque 18 mm. longi, subangulo recto fere assurgentes, teretes, sorediis minutis et convexis obsiti, ramuli ultimi elongati et spinuliformes; medulla myelophypica densa, alba, KHO vix mutata vel demum leviter flavens; axis chondroidea crassa, fere totum latitudinem thalli occupans, pallida, subpellucida, KHO-, J-. Apothecia non visa. — Ex affinitate *Usneae longissimae* Ach. ab ae jam colore et ramis secundariis iteratim ramosus differt.

On rocks in an open field near Aibonito, Fink 1956a.

21. *Buellia* (sect. *Eubuellia*) *sensitiva* Zahlbr. (n. sp.)

Thallus epilithicus, crustaceus, uniformis, tenuis, ad 0.2 mm. crassus, tartareus, isabellinus vel lutuso-cinerascens, opacus, KHO optime sanguineus, CaCl_2O_2 -, areolatus, areolis angulosis, parvis, 0.2–0.3 mm. latis, fissuris tenuibus et acutis separatis, primum planiusculis, demum convexusculis, superne laevigatis,

isidiis et sorediis nullis, in margine linea tenui nigraque bene limitatus; gonidia cystococcoidea; medulla alba, J violacea. Apothecia sat crebra, nigra, opaca, rotunda, usque 0.8 mm. lata, mox convexa, a thallo passim spurie cincta, margine mox depresso; excipulum dimidiatum, nigrum; hypothecium crassum, fere semiglobosum, fusco-nigrum, versus hymenium anguste fuscum; hymenium superne anguste obscuratum, non inspersum, caeterum decolor et purum, 90–100 mic. altum, J violaceo-coeruleum; paraphyses filiformes, strictae, simplices, eseptatae, ad apicem parum lateriore, conglutinatae; asci oblongi vel ellipsoideo-oblongi, superne rotundati et membrana primum bene incrassata cincti, 8 spori; sporae in ascis biseriales, olivaceo-fuscae, variabiles, ellipsoideae vel ovaes, rectae vel curvulae, ad apices bene rotundatae vel modice angustatae, ad septum non vel parum constrictae cellulis aequalibus vel parum inaequalibus, septo tenui, $12-18 \times 6-6.5$ mic.

On rocks in the open near Naranjito, Fink 102.

22. *Buellia* (sect. *Eubuellia*) *naranjitana* Zahlbr. (n. sp.)

Thallus epilithicus, crustaceus, uniformis, late expansus, tenuis, cervinus vel cervino-cinereus, opacus, KHO lutescens, CaCl_2O_2 -, KHO plus CaCl_2O_2 subaurantiacus, continuus, laevigatus vel parum inaequalis, sorediis et isidiis destitutus, lineolis prothallinus, nigris, tenuibus subareolatim percursus, in margine bene limitatus et linea nigra cinctus; gonidia palmellacea, 8–11 mic. lata; hyphae thalli non amylaceae. Apothecia crebra, minuta, ad 0.25 mm. lata, nigra, opaca, lecideina, adpressa, rotunda, primum concaviuscula vel fere urceolata, margine tenui et prominulo, integro cincta, demum plus minus plana vel convexula, margine depresso; excipulum fuligineum, dimidiatum, 70–85 mic. crassum; hypothecium fuscescens; hymenium superne umbrino-fuscum, NO_3 -, caeterum decolor et purum, 75–80 mic. altum, J violaceo-coeruleum; paraphyses filiformes, 3–4 mic. latae, simplices, eseptatae, ad apicem clavatae et infusatae, gelatinose conglutinatae; asci ellipsoideo-clavati, superne rotundati et membrana incrassata cincti, 8 spori; sporae in ascis 2–3 seriales et obliquae, diu decolores, demum fumoso-olivaceae, ellipsoideae vel subovales, utrinque bene rotundatae, rectae, uniseptatae, cellulis membrana inaequaliter incrassata, luminibus cellularum subtriangularibus vel subcornutis, circa $2/3$ longitudinis sporarum metientibus, ad septa normaliter non constrictae, $22-23 \times 8-12$ mic.

On rocks in an open field near Naranjito, Fink 236.

NOTES ON THE AGARICACEAE OF VANCOUVER (B. C.) DISTRICT—I

JEAN E. DAVIDSON

The area dealt with in this article, although comparatively small, is one with an extensive and varied list of Agarics. Owing to the climatic conditions, satisfactory collecting of the fleshy fungi may be accomplished in this district at two seasons of the year. The summer months are normally dry, and but few forms are then to be seen. With the advent of the rainy season, which usually commences toward the end of September, the mushroom flora at once becomes prominent, and continues so until the first sharp frost, which kills the majority of the species. Some forms still persist, however, throughout the winter months, particularly members of the genus *Mycena*, which appear to be peculiarly resistant to low temperatures. The second period of abundance comes in the spring, when the moisture of the winter together with the warmer weather again brings forth a plentiful variety of forms, which continue to flourish until the dry summer weather has definitely set in. September, October, November, December, March, April, and May, are therefore the best collecting months.

The work was begun in the fall of 1926 and has been continued up to the present time, but circumstances would not permit of undivided attention to the subject during the most favorable seasons. The list, therefore, is not complete, but is a contribution towards further investigations in this field. Approximately 130 different species have been collected, and have been recognized as being distinct species, but it has been impossible to identify all of these forms with certainty, further comparative work being necessary to clear up some of the difficulties. The following list includes 81 species of whose identity there is no doubt, and a few others which have been carefully worked out and have been found to be closely related to one or two species, not fitting any one description exactly.

In several cases interesting variations have been observed, and where these are outstanding, a note has been added along with the species. Variations in size were to be expected in some cases, due to the mild weather and abundant moisture during the growing season. In some cases variations in taste and smell occurred. For instance, *Panus stipticus* Fr. is found here with very little taste, if any, in the young forms and also in the mature forms after fairly moist weather, and *Psalliota subrufescens* Pk. lacks both the taste and the smell that is supposed to be characteristic of this species. This would lead us to believe that local modifications in size, taste and smell do occur, and that these characters are not to be relied upon too much for specific differentiation.

The greatest difficulty has been encountered in the genera *Mycena*, *Marasmius*, *Stropharia*, and *Gomphidius*, in which the available literature is insufficient to enable us to identify our forms with certainty. This may be due to the presence here of some new species, but none have been included in this work. So many intermediate forms have been collected, especially in the genus *Mycena*, that it makes us wonder if several of the so-called species are not merely varieties of one species.

The white-spored agarics are by far the most abundant, being represented by 16 genera and 49 species. Purple-brown-spored forms come next with 4 genera and 12 species, followed by ochre-spored forms with 8 genera and 11 species, and black-spored forms with 4 genera and 6 species. The rosy-spored forms are poorly represented, only 2 genera, with 3 species having been satisfactorily identified.

In the following list the genera and species are arranged in alphabetical order within each spore group, and forms which have been found to be closely related to certain species, fitting no one species exactly, are placed in the genus to which they belong, and are marked by an asterisk.

The writer takes this opportunity to acknowledge her indebtedness to Prof. F. Dickson of this University, who has given so much valuable assistance both in the study of the various forms found here, and also in the preparation of the manuscript.

In the following descriptions "Fall" includes September, October, and November; "Winter" includes December, January, and February; "Spring" includes March, April, and May.

WHITE-SPORED GROUP

I. AMANITA

Collected infrequently, from widely separated localities. One species.

1. *Amanita muscaria* Fr. Solitary, in leaf mould in mixed woods. Spring. Infrequent.

II. ARMILLARIA

Represented by one species which occurs frequently.

2. *Armillaria mellea* Fr. Caespitose, mostly on alder and fir. Fall and spring. Common.

III. CANTHERELLUS

Represented by one species.

3. *Cantherellus aurantiacus* Fr. Gregarious, in leaf mould in mixed woods. Fall. Common.

IV. CLITOCYBE

Well represented, but presenting considerable difficulty in determining species. Six species have been recognized.

4. *Clitocybe candida* Bres. Gregarious, in humus in mixed woods. Fall. Fairly common. Grows very large, up to 22 cm. in diameter.
5. *Clitocybe catina* Fr. Gregarious, on lawns. Fall. Common.
6. *Clitocybe inversa* Ricken. Gregarious, in mixed woods. Fall. Common.
7. *Clitocybe laccata* var. *amethystina* Bolt. Caespitose, amongst moss and decaying leaves in moist mixed woods. Fall. Infrequent. The gills of this form were so waxy that it looked much more like an *Hygrophorus* than a *Clitocybe*, but there is no doubt as to its being the late fall form of *Clitocybe laccata* var. *amethystina*.
8. *Clitocybe nebularis* Fr. Solitary or gregarious, in mixed woods. Fall. Fairly common.

9. *Clitocybe pithyophila* Fr. Gregarious to caespitose, on lawns. Fall. Common.

V. COLLYBIA

Only two species so far have been definitely determined.

10. *Collybia conigenoides* Ellis. Grows very abundantly in the fall, attached to buried or half-buried cones of Douglas fir (*Pseudotsuga taxifolia*). Our forms grow as large as 12 mm. in diameter, and the cystidia are broadly ventricose to sub-capitate. This differs slightly from Kauffman's description of the species (Kauffman, Agaricaceae of Michigan, p. 772), but complete descriptions of other cone-inhabiting species are lacking.
11. *Collybia dryophila* Fr. Gregarious to caespitose, in humus in mixed woods. Fall. Infrequent.

Collybia sp. This is a small form which was growing amongst the fallen leaves and needles in mixed woods. Its long root-like prolongation was a very outstanding characteristic. It differs from *C. longipes* Fr. (Kauffman, p. 770) in being smaller and without a velvety pileus. It might be *C. conigena* Fr.-Bres., with which it agrees in color, size, and the root-like prolongation, but it was not attached to cones, and was growing just amongst the needles and humus. It seems to be nearest to *C. conigena* Fr.-Bres., but it cannot be placed there with certainty until a more complete description of that species is available.

VI. HYGROPHORUS

Represented by four species, some of which are of frequent occurrence.

12. *Hygrophorus ceraceus* Fr. Gregarious in humus and moss in mixed woods. Fall. Common. Grows as large as 5 cm., is moist, scarcely viscid, and has short spine-like hairs along margin of pileus.
13. *Hygrophorus eburneus* Fr. Gregarious in humus in mixed woods. Fall. Fairly common.
14. *Hygrophorus miniatus* Fr. Gregarious in decaying leaves in mixed woods. Fall. Rare. Colors of pileus and gills exceptionally vivid.

15. *Hygrophorus psitticinus* Fr. Solitary, in decaying leaves in mixed woods. Fall. Rare.

VII. LACTARIUS

Only one species collected.

16. *Lactarius subdulcis* Fr. Gregarious in decaying deciduous leaves along edge of stream. Fall. Rare. The cuticle has a peppery taste, but the flesh itself is mild.

VIII. LENTINUS

One species collected.

17. *Lentinus ursinus* Fr.-Bres. Gregarious to sub-imbricate on rotting wood. Fall and spring. Infrequent.

IX. LEPIOTA

Represented by two species.

18. *Lepiota Friesii* Lasch. Gregarious to caespitose. In decaying leaves in mixed woods. Fall. Rare.
 19. *Lepiota rubrotincta* Pk. Gregarious in decaying leaves in mixed woods. Fall. Fairly common.

X. MYCENA

Very well represented, presenting several forms which have not yet been definitely identified. A careful study of this genus seems desirable, as there doubtlessly occur in our locality several intergrading forms which would warrant the revision of certain species as at present described. Most of the species listed here are of frequent occurrence.

20. *Mycena acicula* Fr. Gregarious amongst fallen needles, coniferous woods. Fall. Common.
 21. *Mycena alcalina* Fr. Caespitose on mossy logs, in mixed woods. Fall, winter, spring. Common.
 22. *Mycena ammoniaca* Fr. Gregarious amongst decaying leaves in mixed woods. Fall, winter, spring. Common.
 23. *Mycena atroalba* Fr. Gregarious in humus in mixed woods, usually attached to twigs or cones. Fall, winter, spring. Common.
 24. *Mycena clavicularis* Fr. var. *luteipes* Kauff. Sparsely gregarious in humus in mixed woods. Fall. Fairly common.

25. *Mycena cyaneobasis* Pk. Gregarious in humus in mixed woods. Fall and spring. Fairly common.
26. *Mycena excisa* Fr. Caespitose on decaying wood. Spring. Common.
27. *Mycena galericulata* Fr. Caespitose on decaying wood. Spring. Common.
28. *Mycena haematopa* Fr. Caespitose on decaying wood. Fall and spring. Common. (See note at end of this genus, marked by an asterisk.)
29. *Mycena inclinata* Fr. Caespitose on decaying wood. Fall and spring. Common.
30. *Mycena leptcephala* Fr. Caespitose on decaying wood. Fall and winter. Fairly common.
31. *Mycena minutula* Pk. Gregarious, in moss on living maple. Spring. Common.
32. *Mycena parabolica* Fr. Gregarious, in humus in mixed woods. Spring. Common. Our forms grow much larger than is usual for this species, reaching a diameter of 5 cm. No cystidia were seen, but sterile cells were present, globose and finely spiny. This disagrees with Kauffman's description of this species. (Kauffman, Agaricaceae of Michigan, p. 800.)
33. *Mycena polygramma* Fr. var. *albida* Kauff. Caespitose, on decaying wood. Spring. Infrequent. This form varies from Kauffman's description (Kauffman, Agaricaceae of Michigan, p. 801) in lacking cystidia. It closely resembles *M. polygramma* Bull. as illustrated by Atkinson (Atkinson, Studies of American Fungi, p. 94), but Kauffman says that Atkinson's form should be named *M. praelonga* Pk. Our species, however, differs from *M. praelonga* Pk. (Kauffman, Agaricaceae of Michigan, p. 809) in having an almost white pileus, and gills remaining pure white.
34. *Mycena pura* Fr. Gregarious, amongst decaying leaves in mixed woods. Fall and spring. Infrequent.
35. *Mycena rosella* Fr. Sparsely gregarious, in humus in mixed woods. Fall. Fairly common. Our forms are below the average size given for this species.

36. *Mycena sanguinolenta* Fr. Gregarious, on and around old stumps. Fall and spring. Common.

An interesting *Mycena* has been collected on several occasions which seems to be intermediate between *M. sanguinolenta* and *M. haematopa*. It has the crenate edge on the cap characteristic of *M. haematopa* combined with the dark-edged gills of *M. sanguinolenta*. The red edge on the gills is much narrower than in *M. sanguinolenta*. Whether this is a distinct species, or whether it is a form of one of the already described species, or whether it would lead us to believe that *M. sanguinolenta* and *M. haematopa* are really not different species, remains to be seen. The three types are quite commonly found here.

XI. OMPHALIA

Represented by rather few species, two of which have been determined.

37. *Omphalia campanella* (Batsch.) Fr. In dense clusters on moss-covered logs. Fall. Common.
 38. *Omphalia umbellifera* Linn. Densely gregarious on old stumps and logs. Spring, common; fall, infrequent.

XII. PANUS

Represented by two species. Occurrence rather infrequent.

39. *Panus angustatus* Berk. Caespitose, on decaying wood. Fall and winter. Infrequent.
 40. *Panus stipticus* Fr. Caespitose to imbricate, on fallen fir. Spring. Infrequent. The taste is not nearly so astringent as Kauffman describes it (Kauffman, Agaricaceae of Michigan, p. 48), but whether this is due to the immaturity of the specimens, or the abundant rain previous to collection, or whether it is a local variation, is not known.

XIII. PLEUROTUS

Represented by two outstanding species.

41. *Pleurotus candidissimus* B. & C. Caespitose to imbricate, on decaying log. Fall. Fairly common.
 42. *Pleurotus serotinus* Fr. Imbricate, on fallen alder. Winter and spring. Fairly common.

Pleurotus sapidus Kalch.? Imbricate, on decaying wood. Fall. Very common. The color of the spores in mass has yet to be ascertained to separate this form with certainty from *P. ostreatus*, but the gills do not anastomose, so that it tends to lean towards *P. sapidus*.

XIV. RUSSULA

Two species have been collected, both of fairly common occurrence.

43. *Russula emetica* Fr. Solitary, or in two's or three's, amongst decaying leaves in mixed woods. Fall. Fairly common.
44. *Russula veternosa* Fr. Solitary, or in two's or three's, amongst decaying leaves in mixed woods. Fall. Common.

XV. SCHIZOPHYLLUM

Represented by one species, which is fairly common.

45. *Schizophyllum commune* Fr. Imbricate on dead or living trees. Fall, winter, spring. Common.

XVI. TRICHOLOMA

Represented by several species, four of which have been definitely determined. Some are of very common occurrence.

46. *Tricholoma laterarium* Pk. Gregarious, amongst decaying leaves in mixed woods. Fall. Fairly common. Kauffman places this amongst the whitish forms in his key (Kauffman, Agaricaceae of Michigan, p. 680), whereas our specimens possess a brick red pileus. In other respects, however, it agrees with the description.
47. *Tricholoma nudum* Fr. Gregarious on lawns and edges of flower beds. Fall and winter. Very common.
48. *Tricholoma panoecolum* var. *caespitosum* Bres. Gregarious to sub-caespitose, amongst decaying leaves in mixed woods. Fall. Fairly common.
49. *Tricholoma sordidum* Fr. Gregarious to caespitose, on lawns and flower beds. Fall and winter. Very common. The identification of this form was very difficult, due to the pinkish-ochraceous tinge to the spores in mass. The gills are at length emarginate, and all the characters point to the genus *Tricholoma*. Some of the species of

this genus are recorded as having spores not truly white in mass, but no reference was found to this condition being present in *T. sordidum*. It grows commonly associated with *T. nudum*, from which it differs in its larger size, light vinaceous-drab color, and the stem, when cut, lacks the blue or purple color.

Tricholoma sp. (near *T. grave* Pk.). This form has so far eluded identification. It is a very broad (14.5 cm.), very squat form, the length of the stem never more than 4 cm., so that the thick pileus seems to be hardly raised off the ground. It is a brownish-gray color, and was growing in the fine gravel at the edge of a stream. Gills narrowly adnate, almost free. From the large size of the pileus and the color, it might be *T. grave* Pk., but the rooting character of this species was not observed.

OCHRE-SPORED GROUP

XVII. CORTINARIUS

This genus is better represented than any of the other genera in this group. Several species have been collected, but only three have been satisfactorily identified.

50. *Cortinarius alboviolaceus* Fr. On mossy ground in mixed woods. Fall. Infrequent.
51. *Cortinarius squarrosus* Clem. In dense clusters with stems confluent at base, on lawns and around flower beds. Fall and winter. Common.
52. *Cortinarius rigidus* Ricken. Gregarious on twigs of elder (*Sambucus*) and cat-tail (*Typha*) which had fallen on the wet ground around the edge of a lake. Spring. Fairly common in that particular habitat.

XVIII. CREPIDOTUS

Represented by two species.

53. *Crepidotus mollis* Fr. Imbricate on fallen Douglas fir. Fall. Infrequent.
54. *Crepidotus versutus* Pk. Sub-imbricate on decaying wood. Fall. Infrequent.

XIX. FLAMMULA

So far only one species belonging to this genus has been recorded, yet it is certain that more species will be added when more work has been done on it.

55. *Flammula echinulisporus* Murr. Solitary, on roots of cedar (*Thuja*). Fall. Rare.

XX. HEBELOMA

This genus has been recognized, but the species which have been collected here have not yet been satisfactorily identified. A summary of observations on two species is included here.

- *. *Hebeloma* sp. (near *H. albidulum* Pk.). Gregarious, in humus in mixed woods. Fall. Infrequent. This form is placed near the species *H. albidulum* with some hesitancy, because of the difficulty experienced in determining the true condition of the cortina in the earliest stages. Kauffman (Kauffman, Agaricaceae of Michigan, p. 470) in his key separates the species on the basis of the presence, absence, or evanescent character of the cortina. In the young specimens examined, no trace of a cortina could be found, and it was therefore assumed to be absent, our form resembling in this respect *H. albidulum*. Definite differences occur, however. The pilei of our form are larger, reaching 7.5 cm. in diameter; the gills tend to be fairly broad rather than narrow; the stem is decidedly bulbous rather than sub-bulbous, and cystidia are not numerous.

Hebeloma colvini Pk.? Gregarious, in humus in mixed woods. Winter. Infrequent. This agrees fairly well with descriptions of *H. colvini*, but as only two specimens were collected, and only one of them showed the soil adhering like a bulb at the base, that may not be really typical of our forms. Our specimens were found growing in woods, not in "sandy soil in open places" as in Peck's description (Kauffman, Agaricaceae of Michigan, p. 481).

XXI. GALERA

Represented by one species.

56. *Galera tenera* Fr. Gregarious, in grass along roadsides. Spring. Fairly common.

XXII. NAUCORIA

Represented by two species.

57. *Naucoria semiorbicularis* Fr. Gregarious, amongst grass by roadside ditch. Spring. Fairly common.
- *. *Naucoria lignicola* Pk.? Gregarious, amongst moss on bark of living hemlock (*Tsuga*). Spring. Fairly common. Our form differs from *N. lignicola* mainly in the smaller pilei (4–5 mm.), and the much larger spores. The measurements for our spores are $10\text{--}11\ \mu \times 6\text{--}7\ \mu$ as compared with $7\text{--}8\ \mu \times 3\text{--}4\ \mu$ for *N. lignicola* as recorded by Kauffman (Kauffman, Agaricaceae of Michigan, p. 513).

XXIII. PAXILLUS

This genus is of infrequent occurrence, and is represented by only one species.

58. *Paxillus involutus* Fr. Gregarious, amongst bracken and grass at side of road. Fall. Infrequent.

XXIV. PHOLIOTA

Represented by two species which were very easily recognized, though of infrequent occurrence here.

59. *Pholiota adiposa* Fr. Caespitose, on log in moist mixed woods. Fall. Infrequent.
60. *Pholiota destruens* (Fr.) Bres. Sub-caespitose to sub-imbriate, on end of poplar log, in Forest Products drying shed. Fall. Rare.

PINK-SPORED GROUP

XXV. ENTOLOMA

Represented by two species.

61. *Entoloma sericeum* Fr. ~~Densely~~ gregarious to caespitose, on lawns and flower beds. Fall and winter. Common.
62. *Entoloma speculum* Fr. Gregarious to sub-caespitose, amongst fallen leaves in moist, mixed woods. Fall.

Infrequent. The nucleate condition of the spores which Kauffman mentions (Kauffman, Agaricaceae of Michigan, p. 559) is not evident in our form.

XXVI. PLUTEUS

Of very rare occurrence. Represented by only one species, which, so far, has been collected only once.

63. *Pluteus cervinus* Fr. Gregarious, on old stumps. Fall. Rare.

PURPLE-BROWN-SPORED GROUP

XXVII. HYPHOLOMA

The outstanding genus of this group, almost all the species recorded in this genus being of frequent occurrence.

64. *Hypholoma capnoides* Fr. Gregarious, amongst fallen leaves in mixed woods. Fall and early winter. Common.
65. *Hypholoma epixanthum* Fr. Densely caespitose, on dead stumps. Spring. Fairly common.
66. *Hypholoma fasciculare* Fr. Densely caespitose, on decaying Douglas fir in woods. Fall. Common.
67. *Hypholoma hydrophilum* Fr. Sub-caespitose to caespitose on bark of fallen tree. Fall and winter. Common.
68. *Hypholoma sublateralitium* Schaeff. Caespitose, on roots of conifers. Spring. Common.
69. *Hypholoma velutinum* (Fr.) Quel. Gregarious, amongst fallen leaves in woods. Fall. Infrequent.

XXVIII. PSALLIOTA

Not very frequently collected.

- Psalliota abruptibulba* Pk. Solitary, on ground in mixed woods. Fall. Infrequent. The annulus was not noticeably double in the forms collected, this differing from the typical *P. abruptibulba* (Kauffman, Agaricaceae of Michigan, p. 237).
70. *Psalliota haemorrhodaria* Fr. Solitary, amongst decaying leaves in mixed woods. Winter. Infrequent.
71. *Psalliota placomyces* Pk. Gregarious, amongst decaying leaves in mixed woods. Winter. Fairly common.

72. *Psalliota subrufescens* Pk. Sparsely gregarious, amongst fallen leaves, edge of mixed woods. Fall. Infrequent.

XXIX. PSILOCYBE

Represented by one species.

73. *Psilocybe subviscida* Pk. Gregarious, in mossy recently burned-over field. Spring. Common.

XXX. STROPHARIA

Represented by two species.

74. *Stropharia albonitens* Fr. Gregarious, amongst fallen leaves in mixed woods. Fall and winter. Fairly common.
75. *Stropharia stercorearia* Fr. Gregarious, on manure heap. Fall. Fairly common.

BLACK-SPORED GROUP

XXXI. COPRINUS

Represented by two species.

76. *Coprinus comatus* Fr. Gregarious, on lawns and other grassy places. Fall. Fairly common.
77. *Coprinus micaceus* Fr. Caespitose, in humus in mixed woods. Fall. Fairly common.

XXXII. GOMPHIDIUS

A rare genus, represented by one species.

78. *Gomphidius maculatus* Fr. Gregarious, amongst fallen leaves along roadside. Fall. Infrequent. Specimens were collected from two widely separated localities and seemed to be all the same species. They are slightly larger than Kauffman (Kauffman, Agaricaceae of Michigan, p. 170) describes, reaching 6 cm. in diameter, and the veil was not quickly evanescent.

XXXIII. PANAEOLUS

Fairly commonly found, on dung and on lawns recently manured. Represented by two forms which have been definitely determined, and one doubtful species.

79. *Panaeolus campanulatus* Fr. Caespitose, on recently manured lawns. Fall. Fairly common.

80. *Panaeolus retirugis* Fr. Gregarious, on manure heap. Fall. Fairly common.

Panaeolus solidipes Pk.? Gregarious, on manure heap. Fall. Infrequent. Our forms were brown in color, with a polished surface, 4-5 cm. in diameter, and had a striate stem. The size and the striate stem seem to justify its being placed in this species, although the color of the cap is darker than that given in the description (Kauffman, Agaricaceae of Michigan, p. 228).

. XXXIV. PSATHYRELLA

Represented by one species.

81. *Psathyrella crenata* (Lasch.) Fr. Caespitose, on humus in mixed woods. Fall. Fairly common.

DEPARTMENT OF BOTANY,
THE UNIVERSITY OF BRITISH COLUMBIA,
VANCOUVER, CANADA

MOSS-MITES AS SPORE-BEARERS

ARTHUR PAUL JACOT

(WITH 1 TEXT FIGURE)

While making detailed studies of the external anatomy of Oribatoid Acarina, I have repeatedly noted the occurrence of fungus spores both within and attached to the outer walls of their bodies. This association has been specially noticed in connection with the following three types of mites: (1) adhering to the very rough, corrugated, vermiculate or areolated surface of the large Udetaliodes (Neoliodes of authors) which were studied from the eastern states, northeastern China and the Pacific Islands, (2) adhering to or caught in joints of species of the Galumninae (for figures see Jacot, American Oribatid Mites of the Sub-family Galumninae, Bull. Mus. Comp. Zoöl., 69 (1929),

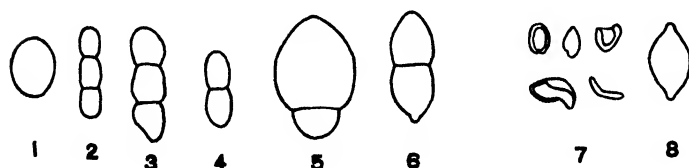


FIG. 1. Various spores found on species of phthiracarine mites from New York, Connecticut and Maine. Fig. 1: 0.0134×0.0097 , also 0.01365×0.00975 and 0.00124×0.00101 ; fig. 2: 0.0123 long; fig. 3: 0.0156×0.00546 ; fig. 4: 0.0101×0.0039 , also 0.01966×0.0123 ; fig. 5: 0.0135×0.00975 ; fig. 6: 0.0151×0.0078 ; fig. 7: 0.0209×0.0111 , also 0.0117×0.0102 and 0.0156×0.0100 ; fig. 8: 0.0148×0.0082 , also 0.0205×0.0082 ; fig. 9: 0.0159×0.0059 . (Dimensions are in millimeters.)

1-37, pl. 3, fig. 24, pl. 6, fig. 55). In this last group spores are often found in the leg cupboards and behind the large leaf-like cupboard doors. This is similarly true of other species of Pterogasterines. (3) Within the body, under various conditions, one species being observed whose stomach was crammed with spores of one kind. These general observations led the writer to make a detailed study of the occurrence of spores on the

Phthiracaridae—chiefly because this group had just been studied and material was still at hand and most familiar. The results follow, but it must be borne in mind that (1) it is impossible to examine undehydrated specimens or parts, (2) it is not feasible to turn over specimens that have been mounted in balsam for some time, and, therefore, that faces whose planes lie at right angles to the plane of observation cannot be examined, (3) these mounted specimens have been picked up by means of a moist camel hair brush, have scrambled over each other for as much as an hour, been killed in boiling water, preserved in alcohol, swashed about in their vials in a drawer for several months, transferred to absolute alcohol, boiled in same, then xylene and finally chased about in a xylene bath in sorting, before being finally mounted. With all this, specimens have been found with one to two dozen spores still adhering to their outer surfaces. Thus the survey is not by any means an indication of the maximum carrying capacity. An examination of 40 lots from New York, Maine, and Connecticut brought out the following facts:

Concerning occurrence: Specimens from (1) under face of bark, boards, slabs and twigs, usually on soft and decayed parts, bore spores, often many; (2) decayed logs and sticks likewise; (3) dead leaves, decaying grass of haystack, *Carex stricta* clump, either top (including fallen leaves and such detritus), or decayed mass on sides of stock, occasionally bore one or two spores; (4) cranberry bog sphagnum occasionally one or two spores but clumps of green sphagnum emerging from swamp level bore none; (5) moss of many kinds bore no spores.

Relation to carriers: Most of the species bore spores. None were found on *Steganacarus diaphanum* and *Pseudotritia simplex*, the two smallest species (and most easily searched). Although species of *Pseudotritia* and *Euphthiracarus* have the anogenital area formed so as to be more receptive than that of the relatively flat bottomed *Phthiracarus*, still the last often bore considerable numbers of spores, especially stuck along the edges of the covers. There are several *Pseudotritia ardua* with thirty odd spores, while the largest number found on a *Phthiracarus* is nineteen. Thus *Pseudotritia* is a better carrier.

Relative to location: Spores were found chiefly about the anterior edge of the genital covers; in the abdomen, especially the area occupied by the legs when retracted; among the legs and mouth parts and under the rim of the aspis (head shield).

Relative to kinds: In general there are many kinds, and of either one, two or three celled species. The largest single celled spore found measures 0.0205 mm. long and is nearly circular. For some others see figures. There seems to be no specificity, *i.e.*, any mite may carry any species of spore with which it may come in contact. One would expect that the majority of these spores belong to fungi dwelling on decaying wood or vegetable matter—the natural habitat of this subfamily.

Although few of the Phthiracarinae climb trees (I have records for only *Pseudotritia ardua* on apple tree) some of the Galumninae and most of the Udetaliodes, besides many other Oribatids, climb trees and ascend vegetation regularly. Udetaliodes are washed off by heavy rains and ascend on cool evenings. Galumninae which ascend herbs do so in the evening and drop off or climb down at dawn. Thus there is a daily migration up and down vegetation. To what extent there is lateral migration has never been determined but it must be considerable during rains. Judging from the number of spores left on mounted specimens, rains must wash off but very few. Thus it is a certainty that many of these mites carry spores and as there are often dozens or hundreds of individuals per square foot of meadow or forest-floor, respectively, the number of spores carried is not negligible.

To what extent such spores may be left on open tissue (the mites are plant feeders, being armed with heavy, shearing mandibles and maxillae) or scraped off on projecting plant parts, *i.e.*, to what extent plants may be inoculated by these carriers, has never been determined.

NOTES ON PENNSYLVANIA USTILAGINALES. I¹

GEORGE L. ZUNDEL

While on agricultural extension trips during the summers of 1928 and 1929, collections of various Ustilaginales have been made, as opportunity has been presented. This has resulted in finding three species of smuts and one new host for a very common smut, that have not* previously been reported from this state. The asterisk (*) preceding the name of a smut or of a host plant indicates that it has not previously been reported from Pennsylvania. The following is a list of species of smuts found on the aforesaid trips together with the host plants, geographic distribution and dates of collection.

ENTYLOMA AUSTRALE Speg., Anal. Soc. Ci. Argent. 10: 5. J1.
1880.

On **Physalis subglabrata* Mack. & Bush:

Lancaster County: Clay, October 12, 1929.

*SOROSPORIUM EVERHARTII Ellis & Gall., Jour. Myc. 6: 32.
1890.

On *Andropogon scoparius* Michx.:

Monroe County: Stroudsburg, August 7, 1929.

On *Andropogon virginicus* L.:

Monroe County: Stroudsburg, August 7, 1929.

SOROSPORIUM SYNTERISMAE (Peck) Farl., Farl. & Seym.
Host Index N. Am. Fungi 152. 1891.

On **Cenchrus tribuloides* L.:

Northumberland County: Montandon, October 8, 1929.

On *Panicum dichotomiflorum* Michx. (*P. proliferum* Am.
auth. not Lam.):

Beaver County: Ambridge-Economy, September 28, 1928.

Dauphin County: Harrisburg, November 15, 1928; Middle-
town, October 23, 1928.

Erie County: Erie, September 12, 1928.

Franklin County: Chambersburg, October 25, 1928.

Luzerne County: Wilkes-Barre, September 11, 1929.

¹ Contribution from the Department of Botany, The Penn'a State College,
No. 68.

- Lycoming County: Williamsport, October 16, 1929.
- SPHACELOTHECA HYDROPIPERIS (Schum.) DeBary, Verg. Morgh. Biol. Pilze 187. 1884.
- On *Polygonum sagittatum* L.:
- Berks County: Robesonia, October 4, 1928.
- *TILLETIA HOLCI (Westend.) Rost., Bot. Tidskr. 22: 256. 1899.
- On *Holcus lanatus* L.:
- Forest County: Red Brush (on the farm of N. A. Korb).
- USTILAGO AVENAE (Pers.) Jens., Charb. Cereales 4. 1889.
- On *Avena* spp.:
- Clearfield County: Grampian, July 24, 1928.
- Franklin County: Scotland, June 26, 1929.
- USTILAGO HORDEI (Pers.) Kellerm. & Swingle, Ann. Rep. Kan. Agr. Exp. Sta. 2: 268. 1890.
- On *Hordeum* spp.:
- Elk County: Wilcox, August 1, 1928; Hyde, August 27, 1928; Boot Jack, August 27, 1929. (Alpha barley.)
- Jefferson County: North Point, July 25, 1928. (Bald barley.)
- USTILAGO LEVIS (Kellerm. & Swingle) Magn., Abh. Bot. Ver. Prov. Brand. 37: 69. 1896.
- On *Avena* spp.:
- Franklin County: Scotland, June 26, 1929.
- USTILAGO NEGLECTA Niessl., Rab. Fungi Eur. 1200. 1868.
- On *Setaria glauca* (L.) Beauv.:
- Beaver County: Beaver Falls, September 24, 1928.
- Berks County: Robesonia, October 4, 1928.
- Centre County: State College, Sept. 3, 1928; Pine Grove Mills, September 18, 1928.
- Franklin County: Bell Valley, September 12, 1928; North East, September 12, 1929.
- Juniata County: McAlisterville, September 20, 1929.
- Lackawanna County: Ransom, September 21, 1928.
- Lancaster County: New Danville, October 12, 1928.
- Lebanon County: Jonestown, September 19, 1928.
- Luzerne County: Orange, September 7, 1928.
- Mercer County: Fredonia, September 11, 1928.
- Northampton County: Mt. Bethel, October 5, 1928.

Pike County: Milford, September 7, 1929.

Union County: West Milton, September 8, 1928.

Warren County: Youngsville, September 13, 1928.

*USTILAGO OXALIDIS Ellis & Tracy, Jour. Myc. 6: 77. 1890.

On *Oxalis corniculata* L.:

Bedford County: Buffalo Mills, August 7, 1928; Bedford, August 30, 1929.

Berks County: Leesport, October 4, 1928.

Blair County: Bellewood, August 8, 1928.

Centre County: State College, July 21, 1928; August 19, 1928.

Columbia County: Catawissa, September 26, 1929; Numidia, September 26, 1929.

Cumberland County: New Kingston, September 18, 1929; Walnut Bottom, September 18, 1929.

Elk County: Ridgway, August 26, 1929.

Forest County: German Hill, August 15, 1929; Tionesta, August 15, 1929.

Franklin County: Scotland, September 17, 1929; Waynesboro, September 17, 1929.

Jefferson County: Baxter, July 25, 1928; Brockway, August 27, 1929; Brookville, August 27, 1929; Roseville, August 27, 1929.

Juniata County: McAlisterville, September 20, 1929; Oakland, September 20, 1929.

Lawrence County: New Castle, August 21, 1928.

Luzerne County: Pikes Creek, September 6, 1929.

Monroe County: Stroudsburg, September 9, 1929.

Northumberland County: Dalmatia, September 5, 1929; Paxinos, October 1, 1929.

Snyder County: Selinsgrove, September 27, 1929.

Union County: Kelly Point, September 8, 1928.

Venango County: Franklin, August 14, 1929; July 26, 1928.

Warren County: Youngsville, September 13, 1928.

Washington County: West Brownsville, August 22, 1928.

Westmoreland County: Lycippus, September 26, 1928.

Wyoming County: Lake Winola, September 10, 1929; Nicholson, September 10, 1929.

On *Oxalis stricta* L.:

Adams County: Cashtown, September 5, 1928.

Columbia County: Catawissa, September 26, 1929.

Jefferson County: Punxsutawney, August 28, 1929;
Reynoldsville, August 28, 1929.

Lancaster County: Elverson, August 28, 1928.

Luzerne County: Nescopeck, October 4, 1929; Orange,
September 11, 1929.

Lycoming County: Cammal, September 14, 1928.

Northumberland County: Dalmatia, September 5, 1929.

Wyoming County: Noxen, September 20, 1928.

USTILAGO RABENHORSTIANA Kuhn, Hedwigia 15: 4. 1876.

On *Digitaria sanguinalis* (L.) Scop.:

Armstrong County: Kittanning, September 25, 1928.

Beaver County: Beaver Falls, September 27, 1928.

Erie County: Erie, September 12, 1928.

USTILAGO STRIAEFORMIS (Westend.) Niessl, Hedwigia 15: 1.
1876.On *Phleum pratense* L.:

Franklin County: Lehmaster, June 26, 1929.

Jefferson County: Baxter, July 25, 1928.

Juniata County: Mifflintown, June 27, 1929.

Mercer County: Sharon, July 9, 1929.

USTILAGO UTRICULOSA (Nees) Tul., Ann. Sci. Nat. III. 7: 102.
1847.On *Polygonum lapathifolium* L.:

Mercer County: Fredonia, September 11, 1928.

Northumberland County: September 5, 1929.

Westmoreland County: Latrobe, September 26, 1928.

On *Polygonum pennsylvanicum* L.:

Luzerne County: Orange, September 7, 1928.

Lycoming County: Cammal, September 14, 1928.

Mercer County: September 8, 1929.

Pike County: Milford, September 7, 1929.

Union County: Kelly Point, September 8, 1928.

Wyoming County: September 20, 1928.

NOTES AND BRIEF ARTICLES

The meetings of the Mycological Section of the Botanical Society of America held in Des Moines, Iowa from December 30, 1929 to January 1, 1930 were well attended and the usual interest manifested in the various papers. The attendance was, however, doubtless reduced somewhat in anticipation of the meeting of the International Botanical Congress to be held in England next summer. The proximity of the State College at Ames gave the visitors a chance to look over the work of that institution, although the meetings of the Mycological Section were held in Des Moines. The New York Botanical Garden was represented by Doctors B. O. Dodge and F. J. Seaver and the substance of the papers presented by them was printed in the January issue of MYCOLOGIA.

A MONOGRAPHIC STUDY OF *CERCOSPORA* SPECIES OF THE WORLD

I think it will be of interest to mycologists and plant pathologists all over the world to know that a very thorough-going taxonomic study of the species of *Cercospora* of the world is being carried through by Dr. Charles Chupp of the Plant Pathology Department at Cornell University. Dr. Chupp, impressed with the difficulty of determining with certainty certain *Cercospora* species which he came across, some years ago began a comprehensive accumulation of the literature and herbarium material of species of this genus. This work has now been under way some ten years. Dr. Chupp has brought together the most complete bibliography of the literature bearing on the taxonomy of these species. He has a very extensive collection of specimens, among them many of the type species. He is making this his special research problem and expects to pursue it intensively, so far as his time allows, during the next few years. He is studying the species grouped by host families, and is, I believe, now in a better position to pass judgment on the identity of species in this genus than anyone else in the world.

While he does not propose to publish on this work for some time yet, he is, nevertheless, very willing to give information and assistance to any worker who may have a problem in the taxonomy of species of *Cercospora*. He has just pointed out to me that very recently descriptions of several new species of *Cercospora* have appeared in which the authors have used names already preëmpted for species of *Cercospora* by earlier workers. This merely adds to the synonymy of the subject unnecessarily. I would suggest that workers proposing to describe new species of *Cercospora* send specimens to Dr. Chupp with description and the name which they propose to use. He is most willing, he assures me, to give such workers full benefit of his knowledge of the genus and assist them in avoiding the application of names already applied to other species.

Dr. Chupp is not keen to publish new species himself but is very anxious to have new species described and published by workers anywhere. He will greatly appreciate duplicate specimens of type species as well as specimens of *Cercospora* from any collector who is willing to send them to him. He will be glad to undertake the determinations of collections of *Cercospora* which anyone cares to send him.

Dr. Chupp is a modest man. I have taken the liberty of calling attention to the work he is doing in the belief that he is rendering a great service to mycologists and plant pathologists and that most of them, the world over, will be glad to take advantage of Dr. Chupp's willingness to be of real service to anyone working on species of this genus.

H. H. WHETZEL



1-4. MYCENASTRUM CORIUM

5-6. GEASTER HYGROMETRICUS

MYCOLOGIA

VOL. XXII

MAY-JUNE, 1930

No. 3

THE DEHISCENCE OF *MYCENASTRUM CORIUM*

W. H. LONG

(WITH PLATE 13)

The Lycoperdales is a group of fungi to which the majority of "puffballs," "devil snuffboxes," etc., belong.

Their methods of dehiscence are many and more or less characteristic and constant for certain genera. The manner in which the peridia split is often made the basis for generic distinctions. In most of the puffballs there is a true dehiscence at maturity, while other species do not have a true dehiscence but depend upon the action of rains, winds, etc., to produce spore dispersion.

In a great majority of the geasters the peridia open when wet and close more or less when dry. There is one genus of the Lycoperdaceae, however, which reverses this process, expanding when dry and closing when wet. This puffball is *Mycenastrum corium*, a species which does not have a true dehiscence like a *Tylostoma* or a *Geaster*, but depends upon weathering for the splitting of its peridium, and the subsequent dispersion of its spores.

Mycenastrum corium is widely distributed throughout the world, having been found in many localities in both hemispheres. It is globular in shape, terrestrial in its habits, and is found throughout the southern United States growing on various types of soil. The writer has found it flourishing in sand, granite debris, black soil and clay, ranging from sea level to 8000 ft. elevation. In hot dry climates it grows in the immediate vicinity

[MYCOLOGIA for March-April (22: 49-102) was issued March 1, 1930]

of trees and shrubs, but not close enough to be shaded throughout the entire day. The young plants are white externally, being covered with a soft cottony layer of mycelium. The peridium is very thick in the earlier stages, ranging from 2-4 mm. thick. The outer white layer is very thin and gradually peels off in weathering. The mature plant does not open in any definite manner, nor does it have any natural mouth. After the spores are ripe the globular fruit body remains attached to the soil for a long time.

The peridium of the mature plant is thick and leathery and remains for several months in an indehiscent condition. Then after alternate wettings and dryings fissures develop across the top (PLATE 13, FIG. 1). These fissures usually radiate from a common center near the apex of the fruit body and finally produce very irregular star-like teeth. In time the entire upper half of the puffball is open and exposed during dry weather (PLATE 13, FIG. 2). In this condition the spores are blown out by the wind and widely distributed. During every rainy spell this puffball promptly closes (PLATE 13, FIG. 3) only to open again when dry weather returns. At each alternate opening and closing the peridium is split more and more, until finally it is expanded into a flat or even recurved shape (PLATE 13, FIG. 4).

Geaster hygrometricus is a fine example of the usual type of dehiscence in which the peridia open when wet (PLATE 13, FIG. 5) and close when dry (PLATE 13, FIG. 6). This difference in method of dehiscence between *Mycenastrum corium* and *Geaster hygrometricus* is due to differences in the structure of the peridia of the two plants. In *Mycenastrum corium* the outer layer of the peridium is composed of cells so arranged that when wet they absorb water and expand, thus closing the top of the puffball. Then when drying these outer cells lose water and gradually shrink, thus producing an unequal tension between the outer and inner cells of the peridium. This causes the irregular star-like pieces of the peridium to gradually separate and curve outward, thus opening the top of the puffball during dry weather.

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DESCRIPTION OF PLATE 13

FIGS. 1-4. Photographs of *Mycenastrum corium*.

1. Development of fissures across the top of the peridium after alternate wetting and drying.

2. Upper half of peridium open during dry weather.

3. Manner of closing during rainy weather.

4. Final stage of expansion of peridium showing its open flat shape.

FIGS. 5-6. *Geaster hygrometricus*.

5. Open wet peridium.

6. Closed dry peridium.

All figures two thirds natural size.

SPHACELOMA SYMPHORICARPI

ANNA E. JENKINS

(WITH PLATES 14 AND 15)

In critical comparisons of organisms of the polymorphic genus *Sphaceloma*, it is helpful to have at hand illustrations, particularly photomicrographs of their microscopic characteristics. These illustrations are available for a number of species, but, so far as the writer is aware, not for *S. Symphoricarpi* Barrus and Horsfall (1), causing the destructive anthracnose of snowberry (*Symphoricarpos albus* Blake, var. *laevigatus* (Fernald) Blake). There are here presented illustrations of the *Sphaceloma* named above, as it occurred in sections through lesions on leaves of snowberry gathered by the writer near Grantsville, Garrett County, Maryland, in August, 1928. The sections, however, were not made until June, 1929, but the organism may have been still viable. This seems the more probable as Scribner (13) noted viability for specimens of the raspberry *Sphaceloma*, of similar age. Not all of the characteristics of the snowberry *Sphaceloma* here depicted have been reported hitherto. Essentially all of them, however, have been discussed in one way or another for this or other closely related species, by various investigators.

The sections were made by means of the freezing microtome, but before sectioning the leaves were placed overnight on moist filter paper in a petri dish. Those here reproduced (PLATE 14 and PLATE 15) are unstained. PLATE 14, *F*, represents the entire thickness of the leaf; all the others show only the upper surface and underlying tissues.

HISTORY AND DISTRIBUTION

The snowberry *Sphaceloma* appears to be fairly common and widespread in this country. It was first described by Barrus and Horsfall in 1928, at which time the only earlier report discovered by them was a brief note by Stewart (14) in which the

fungus was determined as *Gloeosporium* (?) sp. Barrus and Horsfall record the fungus from three counties in New York and from one county each in Arkansas, Iowa and Wisconsin. Its distribution as far west as Colorado has since been reported by Le Clerg (9). To this may be added one locality in the State of Maryland, as indicated above, and another county in New York. The last two records were based on observations of severely diseased snowberry clumps in more or less isolated situations.

Ordinarily the organism appears to infect the upper leaf surface and to fruit thereon rather than the lower. This condition is common to the avocado (*Persea* spp.) and rose (*Rosa*) species of *Sphaceloma* to which reference has previously been made (5, 8). Davis (3) reports anthracnose lesions abundant on the fruit although acervuli are rare.

With respect to the control of the disease Barrus and Horsfall reported certain experiments undertaken by them in the endeavor to find a satisfactory treatment.

DISCUSSION OF ILLUSTRATIONS

Hyphae, usually hyaline or deep reddish brown, and often rather coarse, are shown within or well beneath the epidermis (PLATE 14, *F, a*, and PLATE 15, *D* (arrow), *G, II, I* and *J, b*) as well as closely appressed to compact conidiophore pustules (PLATE 15, *A* and *B*). The two vertical hyphae, shown in PLATE 15, *D*, as extending upward from the oblique hyaline one within the palisade parenchyma, appear to be conidiophores. In most instances, however, the conidiophores have arisen perpendicularly from strands of hyphae extending horizontally through one or more cells of the epidermis (see PLATE 14, *A* and *F*, and PLATE 15, *J, b*, and other figures in the two plates) after the manner illustrated by the writer for the citrus *Sphaceloma* grown (4) in pure culture or developed (6) on its natural host. Seen in section, the acervuli, or sporodochia through their further development, are limited to one or a small number of contiguous epidermal cells, or may extend indefinitely for a considerable distance (see illustrations). The light colored *Stilbum*-like structure shown in PLATE 14, *E, a*, apparently corresponds to certain formations

reported by Osterwalder (10) for the *Sphaceloma* of apple and pear (see 8). On the periphery of the one here illustrated there is visible a cap-like development which appears to be an outer covering of some of its exposed fungus cells (PLATE 14, E, c). Burrill (2), in discussing the raspberry *Sphaceloma* in 1882, stated that Dr. Thomas A. Taylor in an article in the "Small Fruit Recorder" had referred ¹ this *Rubus* organism to the genus *Stibum*. Such being the case, the author cited by Burrill may have observed growths like those here discussed. Similar ones have been seen by the writer (6, 7) in *Sphaceloma* on *Citrus* and Lima bean.

Attached young conidia are shown in PLATE 15, J, a, while similar although larger germinated conidia are illustrated in PLATE 14, A (upper part of figure). Granting that the organism was still viable at the time of sectioning, all this development may have occurred during the time the material was in the moist chamber. In like manner, the germinated conidia of the *Rubus Sphaceloma* observed by Scribner in similar examinations of several-months-old herbarium specimens may have formed, as well as germinated, in his cultures of such material. Swollen *Coniothecium*-like conidia are present in PLATE 14, D (arrow), and PLATE 15, H. The object out of focus in PLATE 15, I (arrow), is a conidium on the surface of which sprout other conidia fully as large for instance as the three primary conidia in PLATE 14, C. These three conidia have apparently formed in succession from the hyaline vacuolate conidiophore beneath them. The septate structure shown in PLATE 15, F, appears to be a differentiated conidium, or a lengthened conidiophore, on the three points of whose apical cell conidia may have been produced.

In the sections minute spherical bodies were not uncommonly seen, often occurring in globular masses, then appearing as a hyaline or yellowish somewhat translucent glistening substance of granular consistency. Each granule appeared to consist of a bright refringent center or mere point surrounded by a thickened apparently mucilaginous substance or wall. All or most of these

¹ Although a search has been made for it the original statement has not been found.

bodies appeared to be microconidia of the organism. On the parts of sections here illustrated, and in some cases still visible as photographed, these microconidia were present in the following figures: PLATE 14, *A* (arrow) = PLATE 15, *E* (arrow), *B* (intermingled with free conidia in concavity between the two acervuli and on the surface of acervulus at right), *C* (intermingled with mass of free conidia at left of fructification), and PLATE 15, *J* (on surface of conidiophores below letter *a*). Granules of practically the same description as those discussed above produced in similar situations have been observed by Prillieux (11, p. 316; 12, pp. 37-38), Viala (15, pp. 304-305, fig. 119), Viala and Pacottet (16, 1905, p. 663, and 1906, p. 89, fig. 22) and by the writer (6, 7) for other species of *Sphaceloma* and another related genus.

Although not illustrated, conidia were present on the lower leaf surface, as well as within the leaf structure where they were apparently borne on hyphae permeating the tissues.

SUMMARY

This account presents photomicrographs depicting the appearance of the anthracnose organism of snowberry, *Sphaceloma Symphoricarpi*, as represented by sections of snowberry leaves gathered at Grantsville, Maryland, August, 1928. The sectioning was not done until several months later, the leaves in the meantime having been dried and preserved as herbarium specimens. Several hours previous to sectioning the leaves were placed in a moist atmosphere. At the time of sectioning the *Sphaceloma* may have been still viable, as was definitely noted by Scribner for specimens of the raspberry *Sphaceloma* of similar age. Not all of the characteristics of the organism depicted have been reported hitherto, but essentially all of them had been observed and discussed in one way or another for closely related species.

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EXPLANATION OF PLATES

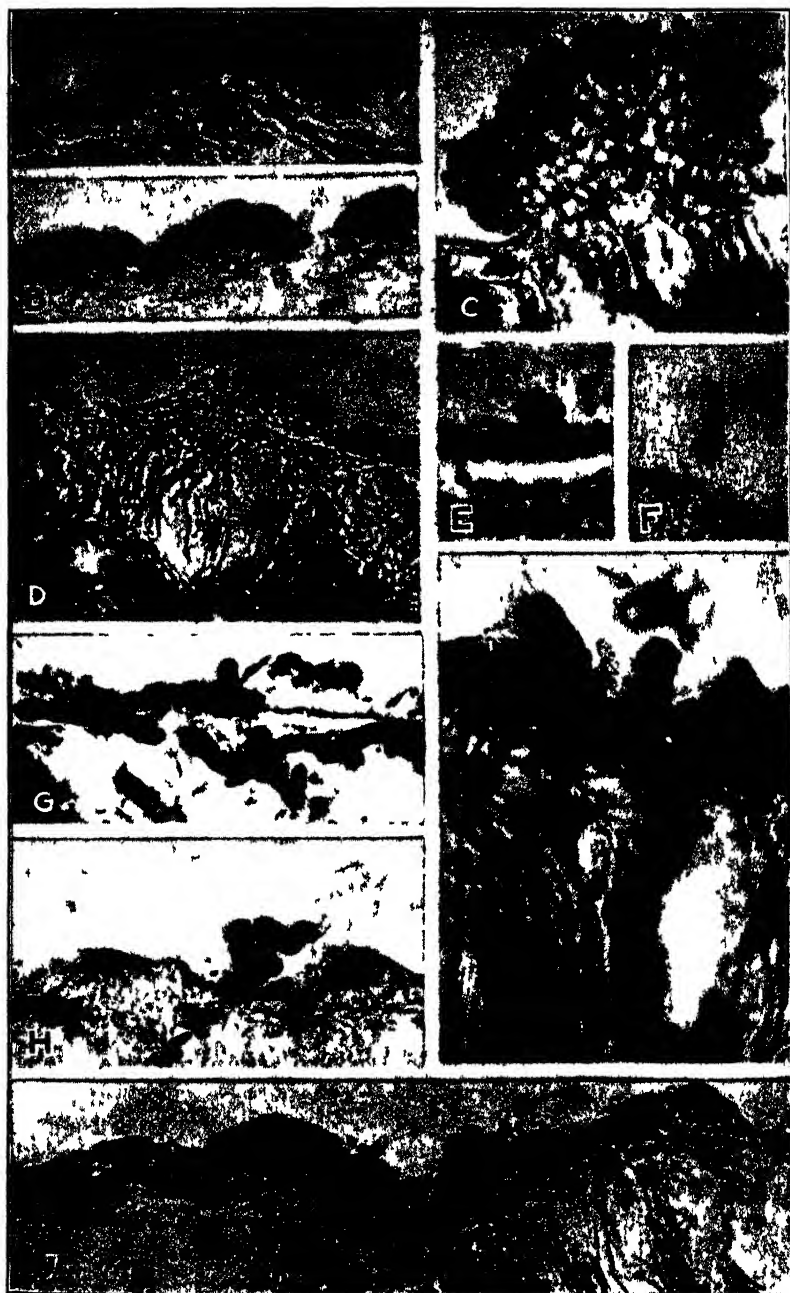
PLATE 14. *Sphaceloma Symphoricarpi*. Conidial fructifications and hyphae on leaves of snowberry, $\times 380$.

PLATE 15. *Sphaceloma Symphoricarpi*. Additional fructifications and hyphae on leaves of snowberry, *E* and *I*, $\times 800$, the others $\times 380$.

(Photographs by Mr. J. F. Brewer.)



SPHACELOMA SYMPHORICARPI



SPHACELOMA SYMPHORICARPI

FUNGI OF SANTO DOMINGO— III. UREDINALES ¹

F. D. KERN AND R. CIFERRI

The first paper in this series was contributed by Rafael A. Toro and published in MYCOLOGIA in 1927 (vol. 19, pp. 66–84). This paper dealt with collections of Phycomycetes, Ascomycetes, and Fungi Imperfecti, and reported 97 species. The second paper was by the senior author and appeared in MYCOLOGIA in 1928 (vol. 20, pp. 60–82). That paper reported 86 rusts of which 30 had been previously reported from Santo Domingo. It should be explained here that we have used the name Santo Domingo as synonymous with the Dominican Republic (Republica Dominicana, official) and not as co-extensive with the island Hispaniola, which includes also the Republic of Haiti (Republique d'Haiti).

The present paper is founded chiefly on collections made by the junior author during 1929. We are indebted to Dr. E. L. Ekman for several fine collections as well as for the determinations of the host plants and the reading of this manuscript. In the following list it is understood that Dr. R. Ciferri is the collector unless there is a notation to the contrary. The abbreviation "Est. Nac. Agr." refers to the Estacion Nacional Agronomica, which is located at Moca, province Espaillat.

Several species are here reported for the first time from Santo Domingo and several new hosts and localities are cited. Among the rusts now being first reported from this region the following are of especial interest: *Puccinia Helianthi-mollis*, *Puccinia Sarachae*, *Uromyces Medicaginis*, *Uromyces Salmeae*, *Endophyllum decoloratum*, and *Pucciniastrum Agrimoniae*.

1. PUCCINIASTRUM AGRIMONIAE (Schw.) Tranz. Scripta Bot. Hort. Univ. Petrop. 4: 301. 1895.

On *Agrimonia parviflora* Sol., Valle del Yaque, prov. Azua, alt. 1500 m., Oct. 5, 1929, Dr. E. L. Ekman 2601.

¹ Read before the Mycological Section of the Botanical Society of America at the Des Moines meeting, December 30, 1929.

Although this rust is widely distributed in North America, and is known also from South America, Europe, and Asia, this is the first report of it from the West Indies.

2. *PROSODIUM TABEBUIAE* Kern, *Mycologia* 20: 63. 1928.

On *Tabebuia Berteri* (DC.) Britt., thickets on savanna near Los Alcarizos, prov. Santo Domingo, alt. 200 m., May, 1929, 2567.

This rust is evidently rare. The host of this specimen agrees so closely with that of the type specimen that we can conclude that the host of the type, which was listed as *Tabebuia* sp., is doubtless *T. Berteri*.

3. *ENDOPHYLLUM DECOLORATUM* (Schw.) Whet. & Olive, *Am. Jour. Bot.* 4: 49. 1917.

On *Wedelia trilobata* (L.) Hitchc., Villa Vásquez, prov. Monte Cristi, June, 1929, 2583.

This is the first report of this species from Santo Domingo.

4. *ENDOPHYLLUM CIRCUMSCRIPTUM* (Schw.) Whet. & Olive, *Am. Jour. Bot.* 4: 49. 1917.

On *Cissus sicyoides* L., Esperanza, on the Mao road, prov. Santiago, June, 1929, 2569; Pimentel, prov. Duarte, August, 1929, 2527.

5. *PUCCINIOSIRA PALLIDULA* (Speg.) Lagerh. *Tromsö Mus. Aarch.* 16: 122. 1894.

On *Triumfetta semitriloba* Jacq., Villa Vásquez, prov. Monte Cristi, July, 1929, 2561 (in part).

6. *BOTRYORHIZA HIPPOCRATEAE* Whet. & Olive, *Am. Jour. Bot.* 4: 47. 1917.

On *Hippocratea volubilis* L., humid forest, near Bonao, prov. La Vega, alt. 400 m., June 22, 1928, 2564.

7. *RAVENELIA INDIGOFERAE* Tranz. *Hedwigia* 33: 369. 1894.

On *Indigofera tinctoria* L., Est. Nac. Agr., Moca, prov. Espaillet, alt. 140 m., July, 1929, 2554.

8. *UROMYCES BIDENTIS* Lagerh. *Bull. Soc. Myc. Fr.* 11: 213. 1895.

On *Bidens pilosa* L., Pimentel, prov. Duarte, August, 1929, 2525.

This microcyclic species is known from Porto Rico, Costa Rica, and South America. This is the first report from Santo Domingo.

9. *UROMYCES CESTRI* (Mont.) Lév. Ann. Sci. Nat. III. 8: 371. 1874.

On *Cestrum macrophyllum* Vent., humid forest, Diego de Ocampo, prov. Santiago, alt. 950 m., July, 1929, 2551.

Not before reported from Santo Domingo.

10. *UROMYCES COLUMBIANUS* Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 467. 1913.

On *Melanthera Buckii* Urban, Agric. Exper. Station, Jaina, prov. Santo Domingo, March 4, 1927, 2579.

This is apparently the first report on this species of host from North America. We have found the rust on three phanerogamic specimens of this host, one from Santo Domingo and two from Haiti as follows: Jarabacoa, prov. La Vega, Santo Domingo, June, 1912, *Padre Miguel Fuertes*; vicinity of Mission, Fondo Verettes, Haiti, Apr. 17–May 4, 1920, *E. C. Leonard* 3614; St. Michel de l'Atalaye, Dept. du Nord, Haiti, Dec. 5, 1925, *E. C. Leonard* 7737.

11. *UROMYCES DOLICHOLI* Arth. Bull. Torrey Club 33: 27. 1906.

On *Cajan Cajan* (L.) Millsp. (*C. indicus* Spreng.), Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., July, 1929, 2550; Villa Vásquez, prov. Monte Cristi, July, 1929, 2560.

12. *UROMYCES MEDICAGINIS* Pass.; Thüm. Herb. Myc. Oecon. 156. 1874.

On *Medicago sativa* L. cult., Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., March 8, 1928, II, III, 2568; Villa Vásquez, prov. Monte Cristi, June, 1929, II, III, 2576.

This rust on alfalfa is widely distributed in North America, is known also in Europe, India, and South America, but has been known previously from the West Indies only from Cuba.

13. *UROMYCES PROËMINENS* (DC.) Pass. Rab. Fungi Eu. 1795. 1874.

On *Chamaesyce hirta* (L.) Millsp. (*Euphorbia pilulifera* L.), Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., May, 1929, 2580.

Chamaesyce hypericifolia (L.) Millsp. (*Euphorbia hypericifolia* L.), near Rincon road, prov. La Vega, July, 1929, 2572; Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., May, 1929, 2581.

Chamaesyce nutans (Lag.) Small (*C. Preslii* Arth., *Euphorbia nutans* Lag.), Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., May, 1929, 2573.

14. *UROMYCES SALMEAE* Arth. & Holw. Am. Jour. Bot. 5: 445. 1918.

On *Salmea scandens* (L.) DC., humid forest, Diego de Ocampo, prov. Santiago, alt. 950 m., July, 1929, O, I, 2586.

The first report of this species outside of Porto Rico and Guatemala.

On a phanerogamic specimen of *S. scandens*, H. von Türckheim 3050, collected in March, 1910, near Constanza, prov. La Vega, teliospores have been found.

15. *PUCCINIA CANALICULATA* (Schw.) Lagerh. Tromsø Mus. Aarch. 17: 51. 1894.

On *Cyperus Haspan* L., in savanna near Pimentel, prov. Duarte, August, 1929, 2575.

A new host for North America.

16. *PUCCINIA CANNAE* (Wint.) P. Henn. Hedwigia 41: 105. 1902.

On *Canna coccinea* Ait., humid forest near La Vega, prov. La Vega, alt. 150 m., June, 1929, 2577.

17. *PUCCINIA HELIANTHI-MOLLIS* (Schw.) Arth. Résult. Sci. Congr. Bot. Vienne 344. 1906.

Puccinia Helianthi Schw. Schr. Nat. Ges. Leipzig 1: 73. 1822.

On *Helianthus annuus* L. cult., Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., July, 1929.

This is the first report of the sunflower rust from Santo Domingo. It has heretofore been known in the West Indies only in Cuba. It is a common species in the United States, southern Canada, and Europe.

18. *PUCCINIA HETEROSPORA* Berk. & Curt. Jour. Linn. Soc. 10: 356. 1868.

On *Sida urens* L., Diego de Ocampo, Santiago, alt. 900 m., July, 1929, 2559; Villa Vásquez, prov. Monte Cristi, July, 1929, 2561.

19. *PUCCINIA LEONOTIDIS* (P. Henn.) Arth. Mycologia 7: 245.

1915.

Puccinia dominicana Frag. & Cif. Bol. R. Soc. Esp. Hist. Nat.
 26: 248. 1926.

On *Leonotis nepetaefolia* (L.) R. Br., Est. Nac. Agr., Moca,
 prov. Espaillat, alt. 140 m., June, 1929, 2584; Santo
 Domingo City, prov. Santo Domingo, Dec. 15, 1929,
Dr. E. L. Ekman 2828.

20. PUCCINIA MALVACEARUM Bert. Mont. in C. Gay, Fl. Chil. 8:
 43. 1852.

On *Malvastrum coromandelianum* (L.) Garcke, Est. Nac. Agr.,
 Moca, on the road to Jamao, prov. Espaillat, alt. 140 m.,
 June, 1929, 2574.

Malvastrum spicatum (L.) A. Gray, Est. Nac. Agr., Moca,
 prov. Espaillat, alt. 140 m., June, 1929, 2582.

The latter is a new host for North America.

21. PUCCINIA POROPHYLLI P. Henn. Hedwigia Beibl. 39: 153.
 1900.

On *Porophyllum ellipticum* Cass., Est. Nac. Agr., Moca,
 prov. Espaillat, alt. 140 m., June, 1929, 2571.

This is an extension of the distribution of a species previously
 known from southern Mexico and northern South America.

22. PUCCINIA SARACHAE Mayor, Mem. Soc. Neuch. Sci. Nat. 5:
 499. 1913.

On *Saracha antillarum* Krug & Urban, Valle Nuevo, prov. La
 Vega, alt. 2500 m., Oct. 16, 1929, *Dr. E. L. Ekman* 2617.

The first report from Santo Domingo of a South American
 species which is known also in Costa Rica and Jamaica.

23. PUCCINIA URBANIANA P. Henn. Hedwigia 37: 278. 1898.

On *Cornutia pyramidata* L., Los Alcarrizos road, prov. Santo
 Domingo, June, 1929, 2565; banks of Rio Ozama, prov.
 Santo Domingo, Dec. 15, 1929, *Dr. E. L. Ekman* 2830.

24. PUCCINIA VERSICOLOR Diet. & Holw. Bot. Gaz. 24: 28.
 1897.

On *Heteropogon contortus* (L.) Beauv., Monción, prov. Monte
 Cristi, alt. 475 m., June, 1929, 2558.

This is another extension of distribution of a rust originally
 described from southern Mexico and since reported from Hawaii.

25. PUCCINIA XANTHII Schw. Schr. Nat. Ges. Leipzig 1: 73.
 1822.

On *Xanthium chinense* Mill. (*X. echinatum* of Urban, not Murr.), Pimentel, prov. Duarte, August, 1929, 2526; humid forest, Diego de Ocampo, prov. Santiago, alt. 650 m., July, 1929, 2557; Esperanza, on the Mao road, prov. Santiago, July, 1929, 2570.

26. *AECIDIUM ABSCEDENS* Arth. Mycologia 7: 315. 1915.

On *Randia aculeata* L., banks of Rio Ozama, prov. Santo Domingo, Dec. 14, 1929, Dr. E. L. Ekman 2765.

A new rust for Santo Domingo where it is apparently rare. This species has been known previously from Porto Rico, Costa Rica, and southern Mexico.

27. *Aecidium domingensis* sp. nov.

0. Pycnia chiefly hypophyllous, in small orbicular groups, punctiform, globoid or ovate, 150–175 μ in diameter.

1. Aecia chiefly hypophyllous, in orbicular groups 2–4 mm. across. Surrounding the pycnia, bullate, roundish, 0.3–0.4 mm. across, long covered by the overarching epidermis; aeciospores ovoid, sometimes pyriform, often angular and narrowed both above and below, 24–31 by 42–52 μ , the wall 1.5–2 μ thick, somewhat thicker above, 3–4 μ , colorless, sparsely echinulate-verrucose.

On *Baccharis myrsinites* (Lam.) Pers., Diego de Ocampo, prov. Santiago, alt. 1250 m., August, 1929, R. Ciferri 2524.

The form here described does not agree with any of the several species described on *Baccharis*. It is similar to *Puccinia evadens* in having large colorless spores with wall thicker above, but differs in the thickness of the walls and surface markings as well as in the gross characters of the sori and their distribution.

28. *AECIDIUM TOURNEFORTIAE* P. Henn. Hedwigia 35: 253. 1896.

On *Tournefortia hirsutissima* L., Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., May, 1929, 2563.

29. *UREDIO BULLULA* Kern, Mycologia 20: 77. 1928.

On *Eupatorium odoratum* L., near Colonia Jamar, Moca, prov. Espaillat, alt. 700 m., July, 1929, 2566.

30. *UREDIO TOROIANA* Kern, Mycologia 20: 76. 1928.

On *Vernonia cinerea* (L.) Less., Est. Nac. Agr., Moca, prov. Espaillat, alt. 140 m., July 4, 1929, 2562.

In addition to this collection this rust has been found on a phanerogamic specimen of *Vernonia cinerea* collected by *E. C. Leonard*, no. 7452, at St. Michel de l'Atalaye, Dept. du Nord, Haiti, making four widely separated stations on the island.

THE PENNSYLVANIA STATE COLLEGE,
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REPUBLICA DOMINICANA.

THE NON-SEXUAL STAGE OF APHANOMYCES PHYCOPHILUS

F. K. SPARROW, JR.

(WITH 1 TEXT FIGURE)

Although it has been nearly seventy years since de Bary described the first algae-parasitizing species of *Aphanomyces*, *A. phycophilus* (1), little has been added to our knowledge concerning the habits and distribution of these interesting forms. It was a matter of some surprise to the writer, upon reading the extant papers concerning the aforementioned species, to find that, while the sexual stage of this fungus has been observed in several instances since de Bary's time, in no case had the discharged sporangia been seen. During the past summer while investigating the parasites of algae found in the vicinity of Cold Spring Harbor, L. I., the writer was fortunate in finding not only numerous oöspores of this species, but several discharged sporangia as well. Because of the apparent rarity of the non-sexual stage of this fungus and for the reason that in the Saprolegniaceae, to which *Aphanomyces* belongs, it is of considerable taxonomic significance, the preparation of this brief note has seemed advisable. Furthermore, from a careful reading of de Bary's original description it is evident that he himself never observed the sporangia in the condition necessary for the complete identification of his fungus.

The fungus was found near the laboratory of the Long Island Biological Association, parasitic in an internodal cell of *Nitella* sp. (?), a host hitherto unreported as being attacked by any species of *Aphanomyces*. Attention was immediately directed to the fungus because of its conspicuous golden oöspores, the oögonial walls of which were similarly colored and covered with spine-like protuberances of varying length. Further investigation revealed the stout hyphal threads ramifying throughout the cell and several extramatrical sporangia. Each of the latter structures possessed an apical cluster of cystospores from which

practically all of the zoöspores had emerged. A careful examination of these sporangia showed them unquestionably to have originated from the same mycelium which bore the aforementioned oöspores.

The sporangium of *Aphanomyces phycophilus* is similar to that found in other species of the genus and, from the standpoint of its morphology, presents no particular features (TEXT FIG. 1a). It is simply a slender lateral branch of the mycelium which has penetrated, with no noticeable constriction of its diameter, the host cell wall, and which has extended for a varying distance out into the water. The diameter of this structure, although tapering slightly at its apex, is around $3.4\ \mu$. Actual discharge of the zoöspores from the evacuation tube and their characteristic emergence after a period of quiescence from the cystospores were not observed. It is presumed, however, that these processes occurred as in other species of *Aphanomyces*. The number of cystospores formed at the mouth of the evacuation tube was not numerous, seven being the maximum observed in the writer's material. These were $9.6\ \mu$ in diameter.

Save for emphasizing the golden color of the mature oöspore, the present writer can add nothing of importance to the descriptions of de Bary (1) and Weatherwax (6) of this structure (TEXT FIG. 1b). It should be noted, however, that the diameters of the oögonia found in *Nitella* were on the whole somewhat smaller than those given for this species ($26\text{--}38\ \mu$ as compared with $40\text{--}50\ \mu$). In this, they more nearly approach the size ($26\ \mu$) attained by the form found by Weatherwax.

De Bary first described this species from Germany in 1860 (1), where he found it parasitic in *Spirogyra lubrica* Kütz and *S. nitida* Kütz. The fungus was again reported in 1914 from Indiana by Weatherwax (6) as a parasite of *Spirogyra dubia* Kütz. The following year it was recorded from Michigan by Kauffman (3) and from Germany by von Minden (4), parasitizing in both instances species of *Spirogyra*. It might be noted at this time that the writer has examined material of this fungus collected in 1893 at York, Maine, by Dr. Roland Thaxter.¹

¹ The writer wishes to thank Professor Thaxter at this time for his kindness in allowing him to examine not only this material but that of a number of other Phycomycetes.

As in the preceding instances, the fungus was found by him parasitic in *Spirogyra*.

Thus far but three other species of *Aphanomyces* have been described as parasites of algae. *A. norvegicus* Wille, differing from *A. phycophilus* in the dark brown color of its oöspore and oögonial walls, has been described by Wille (7) as a parasite of

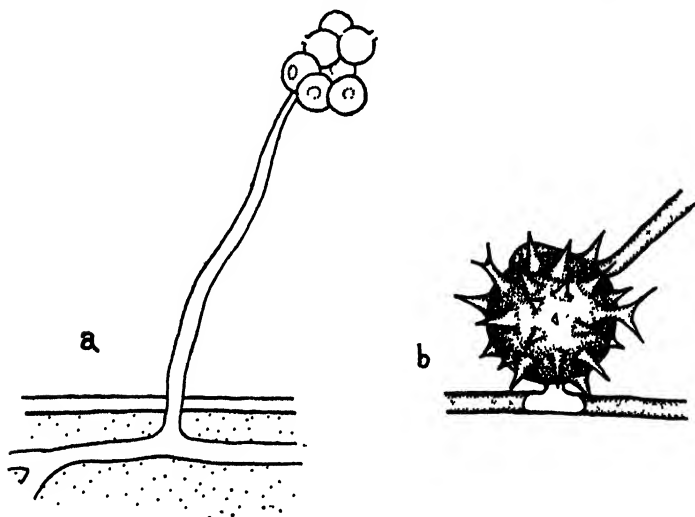


FIG. 1. (a) Discharged sporangium of *A. phycophilus* with apical cluster of empty cystospores, protruding from an infected cell of *Nitella* sp. (?). Content of the host cell is not shown but was normal. (b) Surface view of oögonium of fungus showing characteristic projections and a portion of the antheridium. Drawings were made from living material with the aid of the camera lucida. Approximately $\times 225$.

Zygnema, *Spirogyra*, and *Mougeotia* in Norway. A form considered to be *A. laevis* de Bary by Coker (2) has been found by him as a parasite of diatoms and desmids in North Carolina. Recently, Skvortzow (5) has described from Manchuria a parasite of *Vaucheria sessilis* (Vauch.) DeCandolle and *V. uncinata* Kütz, termed by him *Aphanomyces Gordejewi* n. sp. There is reason to doubt, however, that this species really belongs to *Aphanomyces*, as only discharged sporangia were observed and these did not show evidences of the apical clusters of cystospores, nor were the meagre descriptions and poor drawings of the mature sex organs convincingly saprolegniaceous. On the con-

trary, the antheridia strongly resemble those formed by certain species of *Pythium*. Further, in no case was a *mature* oöspore figured.

Although the non-sexual stage of *A. phycophilus* is apparently recorded for the first time in this paper, there is little reason to believe it to be of rare occurrence, and it is hoped that further investigation by others interested in this group of organisms will yield a more thorough account.

THE BIOLOGICAL LABORATORY,
LONG ISLAND BIOLOGICAL ASSOCIATION,
COLD SPRING HARBOR, L. I.

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PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XI. SOLENOPEZIA ¹

FRED J. SEAVER

(WITH PLATE 16)

The above named genus was founded by Saccardo on *Peziza Solenia* described by C. H. Peck in 1873. In working over material in the herbarium of The New York Botanical Garden, the writer encountered an excellent specimen which is apparently a part of the type collection.

Since this was made the type of a genus and so little is known of it, the writer is taking this opportunity to describe the plant more in detail and supply illustrations. This is done with the hope of focusing attention on the fungus and possibly bringing in more material for study. It would seem very strange if other collections had not been made. The apothecia are so minute that it is impossible to get satisfactory photographs and it will be necessary to rely on drawings.

The apothecia are small and the mouths so constricted that they might easily be mistaken for the perithecia of a *Nectria*. However, when moist, the mouth does gradually expand although the hymenium never becomes conspicuously exposed. The species is characterized by two types of hairs on the outside of the apothecium, hyaline-tipped hairs about the mouth giving rise to a white border and dark-brown hairs below and covering the remainder of the apothecium.

A second species, *Solenopezia vulpina* (Cooke) Sacc., was included in the genus by Saccardo. This was originally described by Cooke as a *Peziza* but, as pointed out by the writer (Bull. Torrey Club 36: 203. 1909), this is a synonym of *Nectria*. *Peziza*, and should be excluded from the genus *Solenopezia*.

Later two additional species were referred to the genus:

¹ This paper is preliminary to a monograph of North American Cup-fungi (Inoperculates), a companion volume to North American Cup-fungi (Operculates) which was published by the author and issued in December, 1928.

Solenopezia Symphoricarpi Ellis & Ev. (Jour. Myc. 9: 165. 1903) and *Solenopezia fimbriata* Ellis & Barth. (Jour. Myc. 8: 174. 1902). Neither species has been seen and no statement can be made regarding them at the present time.²

The writer would be glad to receive any material which seems to belong to this genus for study in connection with his monograph of the North American Cup-fungi. The following is the diagnosis of the genus and type species.

SOLENOPEZIA Sacc. Syll. Fung. 8: 477. 1889.

Apothecia sessile, minute, urceolate or rarely hemispherical, brown or light colored, externally clothed with hairs; asci typically 8-spored; spores ovoid, ellipsoid, or subfusoid, 1-septate, hyaline.

Type species: *Peziza Solenia* Peck.

SOLENOPEZIA SOLENIA (Peck) Sacc. Syll. Fung. 8: 477. 1889.

Peziza Solenia Peck, Ann. Rep. N. Y. State Mus. 25: 99. 1873.

Apothecia gregarious, sessile, minute, not exceeding .3 mm. in diameter, short cylindric, a little longer than broad, constricted at the mouth, externally clothed with brown hairs but with a white margin around mouth; hymenium not much exposed; hairs consisting of two kinds, those about the sides of the apothecium dark-brown, clavate, septate, slightly roughened and knotted, reaching a diameter of 5–6 μ and a length of 60–80 μ , the marginal hairs similar in size and form but hyaline tipped and covered with minute granules; asci clavate, reaching a length of 65 μ and a diameter of 10 μ ; spores 2-seriate, fusoid, hyaline, becoming 1-septate, usually with 4 small oil-drops, about 3–4 \times 12–13 μ ; paraphyses filiform, slightly enlarged above.

On dead stems of *Eupatorium ageratoides*.

Type locality: Watkins Glen, New York.

Distribution: Known only from the type locality.

The above description and accompanying illustration were drawn from material in the herbarium of The New York Botanical Garden which is apparently part of the type collection.

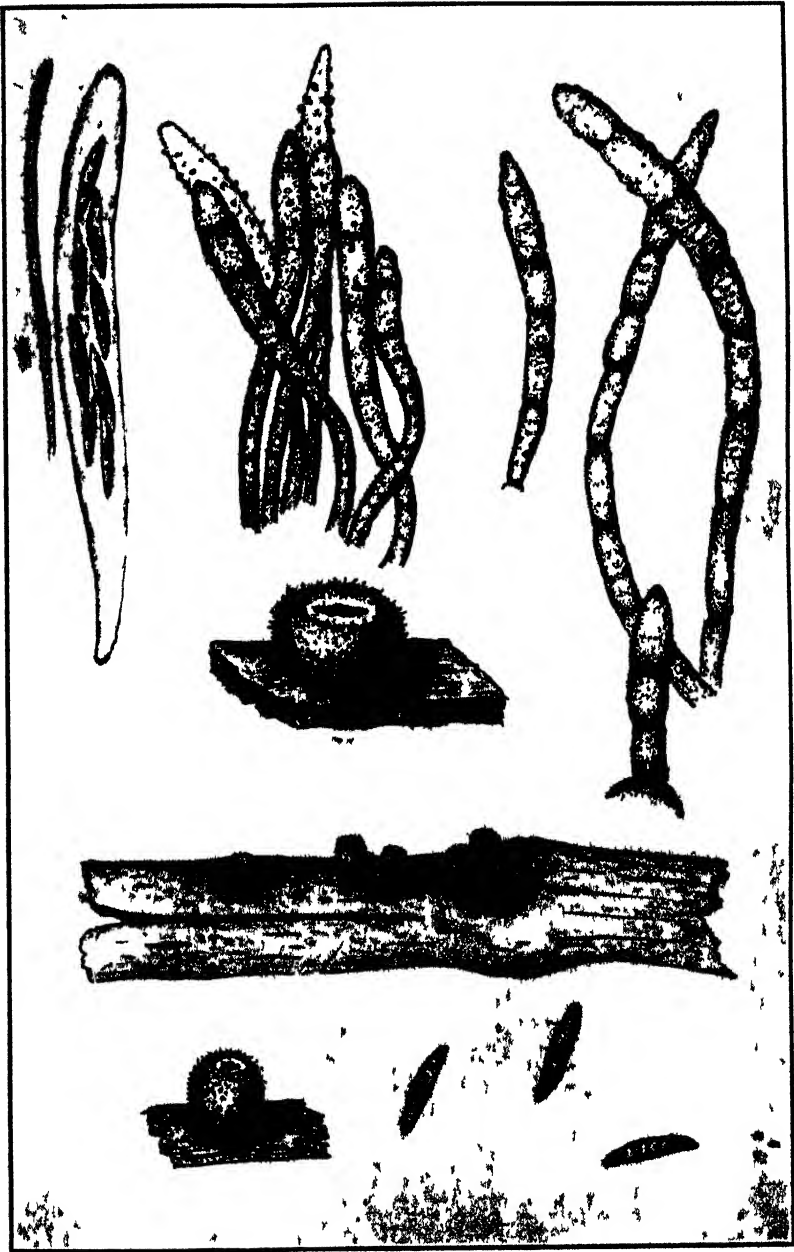
THE NEW YORK BOTANICAL GARDEN

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²Since the writing of this article type material of *Solenopezia fimbriata* loaned the writer by Dr. Elam Bartholomew of Hays, Kansas, shows it to be one of the Phacidiaaceae and apparently a *Diplonaevia*. It is close to *Diplonaevia melaleuca* Ellis & Ev.

EXPLANATION OF PLATE 16

Drawing of a cluster of apothecia several times enlarged and two isolated apothecia greatly magnified. Also drawings of asci with spores and paraphysis and hairs from the outside of the apothecium. Cluster near the center showing the two kinds, the hyaline tipped and the brown. Asci spores and hairs drawn with the aid of the camera lucida.



SOLENOPEZIA SOLENIA

MONOGRAPHIC STUDIES ON THE USTILAGINALES ATTACKING ANDROPOGON¹

GEORGE LORENZO INGRAM ZUNDEL

While pursuing general studies on the Ustilaginales, it was found that fifty-nine species attack the genus *Andropogon*. At the suggestion of Dr. George Perkins Clinton, monographic studies of these species were made, under his direction, in the Osborn Botanical Laboratory, Yale University, and the botanical laboratory of the Connecticut Agricultural Experiment Station during 1927-1928. Specimens in the Clinton herbarium together with the personal specimens of the writer comprised most of the available working material. It was, however, necessary to secure the loan of type specimens of certain species from the Royal Botanic Gardens, Kew; the Jardin Botanique de l'Etat, Bruxelles; the Museum d'Histoire Naturelle, Paris; the Botanischer Garten und Museum, Berlin-Dahlem, for which acknowledgment and thanks is here given. It was further necessary to secure specimens of other species from the Department of Agriculture, Malta; the Bureau of Science, Manila, Philippine Islands, and from Dr. Rene Maire of Algiers, for which acknowledgment and thanks is given. Through the coöperation of all available agencies it has been made possible for the writer to personally examine spores of all but two species included in these studies, viz., *Sorosporium dembianense* Bacc. and *Sorosporium Heteropogon-contorti* Bacc. The description included in these studies of these two species is, therefore, based on the original description without a personal study of material.

Studies of material from the Agricultural Department of the Union of South Africa and other sources have given eighteen new species for which the following names are proposed: *Sorosporium Flanaganianum*; *Sorosporium proliferatum*; *Sorosporium*

¹ Contribution from the Osborn Botanical Laboratory, Yale University, and part three of a dissertation presented to the graduate school in partial fulfillment of the degree of doctor of philosophy, June, 1929.

Clintonii; *Sorosporium austro-africanum*; *Sorosporium harrismithense*; *Sorosporium Healdii*; *Sorosporium Hodsonii*; *Sorosporium pretoriense*; *Sphacelotheca Ritchiei*; *Sphacelotheca Doidgeae*; *Sphacelotheca Holwayi* Clinton & Zundel; *Sphacelotheca Evansii*; *Sphacelotheca concentrica*; *Sphacelotheca Kellermanii* Clinton & Zundel; *Sphacelotheca Moggii*; *Sphacelotheca Natalii*; *Sphacelotheca Transvaalii*; *Sphacelotheca Zilligii*.

In this paper there are seventy-six species of Ustilaginales reported as occurring on the genus *Andropogon* as follows:

<i>Contractia</i>	1 species
<i>Sorosporium</i>	28 species
<i>Sphacelotheca</i>	39 species
<i>Tolyposporella</i>	3 species
<i>Ustilago</i>	5 species

The following two species have been excluded from the Ustilaginales:

Thecaphora Berkeleyana Fisch. On *Andropogon perforatus*. This fungus upon microscopic examination proved to be close to *Cerebella Andropogonis* or *Epicoccum* sp.

Tolyposporium philippinense H. & P. Sydow. This is an *Epicoccum*-like saprophyte.

In the descriptions of the new species U. D. Agr. equals Herbarium of the Department of Agriculture, Union of South Africa.

The genus *Andropogon* as used in these studies is as defined by Engler in "Die Natürlichen Pflanzenfamilien." This genus generally prefers dry plains, savannahs, etc., in both the northern and southern hemispheres.

USTILAGO (Pers.) Roussel, Fl. Calvados, ed. 2. 47. 1806.

Spores 3-8 μ diameter.

Sori destroying inflorescence..... *U. amadelpa*

Sori forming on the surface of sheath and leaves
as striae or granular masses.

Spores 3-6 μ diameter..... *U. effusa*

Spores 5-8 μ diameter..... *U. occulta*

Spores 5-12 μ diameter.

Sori attacking ovaries.

Spores echinulate..... *U. Andropogonis-finitimi*

Sori transforming floral stem into long, curved
leafless outgrowth.

Spores smooth..... *U. consimilis*

1. USTILAGO AMADELPHA H. & P. Sydow & Butler, Ann. Myc. 10: 249. 1912.

Sori up to 8 cm. long, involving and destroying the entire inflorescence, at first hidden by the terminal sheath, surrounded by host tissue which breaks up into long, more or less curled, silvery shreds, revealing a dark brown mass of spores; spores reddish brown, globose-subglobose, rarely elliptical, very obscurely but abundantly echinulate under the oil immersion lens, 5–8 μ diameter.

On *Andropogon* sp.: India²

2. USTILAGO EFFUSA H. & P. Sydow, Ann. Myc. 4: 425. 1906.

Sori forming on the inner surfaces of the sheath and of the leaves as long striae which fuse, forming a dense mass of dark brown spores; spores light olive brown, globose-subglobose, minutely verruculose under oil immersion, 3–6 μ diameter.

On *Andropogon squarrosus* (*A. muricatus*): India. *Andropogon Wallichii*: India.

3. USTILAGO OCCULTA P. Henn. Hedwigia 36: 212. 1897.

Sori on the culms and inner parts of sheaths and leaves forming a black granular mass of spores; spores globose-subglobose, sometimes oblong, dark brown to almost black, minutely and abundantly verruculose, especially under the oil immersion, 5–8 μ diameter.

On *Andropogon* sp.: Brazil.

4. USTILAGO ANDROPOGONIS-FINITIMI Maub. Bull. Soc. Myc. (France) 22: 74–75. 1906.

Sori in the ovaries, long linear, 5–7 mm. long, covered with a membrane of host tissue; spore mass brown, agglutinated, surrounding a well developed columella; spores dark reddish brown, globose-subglobose, semi-opaque, under oil immersion very abundantly echinulate, 9–12 μ diameter.

On *Andropogon finitimus*: Portuguese East Africa.

5. USTILAGO CONSIMILIS H. Sydow,² Ann. Myc. 22: 281. 1924.

Sori transforming the floral stem into a long, curved, leafless stem-like outgrowth covered by a thin covering of host tissue;

² In 1924, H. Sydow found that *Ustilago Sacchari*, which was described by Rabenhorst in 1871 on *Erianthus Ravennae*, was not the smut that occurred on sugar cane. The sugar cane smut was, therefore, named *Ustilago consimilis*.

the lower part of the sori concealed by the sheath; spores reddish brown, globose-subglobose, smooth, 5–12 μ diameter; groups of hyaline thin-walled cells scattered throughout the sori.

On *Andropogon Sorghum* (*Saccharum vulgare*): Italy; Philippine Islands. *Saccharum cylindricum* (*Imperata arundinaceae*): Union of South Africa (Natal). *Saccharum erianthoides* (*Erianthus saccharoides*): Union of South Africa (Natal). *Saccharum fuscum*: India. *Saccharum officinarum*: Union of South Africa (Natal); India; Japan; Philippine Islands. *Saccharum spontaneum*: Philippine Islands.

CINTRACTIA Cornu, Ann. Sci. Nat. VI. 15: 279. 1883

1. **Cintractia Vanderystii** (P. Henn.) Zundel, n. comb.

Ustilago Vanderystii P. Henn. Ann. Mus. du Congo V. 2: 86. 1907.

Sori in the ovary, destroying the inflorescence; spore masses agglutinated around a central columella, dark brown; spores dark reddish brown, usually globose-subglobose, somewhat angular, smooth, 6–10 μ diameter.

On *Andropogon* sp.: Congo.

SPHACELOTHECA de Bary, Verg. Morph. Biol. Pilze 187. 1884

Sori involving the ovaries.

Sori 1 cm. or less in length.

Spores 3–8 μ diameter.

Sori long linear.

Spores 4–6 μ , light olive to nearly

hyaline..... *S. Moggii*

Spores 5–7 μ , dark reddish brown *S. furcata*

Spores 6–10 μ , olive brown..... *S. Doidgeae*

Sori not long linear.

Spores 4–6 μ *S. sorghicola*

Spores 5–9 μ .

With groups of large sterile

cells..... *S. cruenta*

With chains of small globose

cells..... *S. Sorghi*

Spores 8–9 μ diameter.

Sterile tissue with evanescent cells .. *S. Andropogonis-annulati*

Sterile tissue with non-evanescent cells *S. Evansii*

Spores 9–12 μ diameter.

Sterile cells single, 11–16 μ diameter. *S. Nyassae*

Sterile cells in groups or chains, 7–12 μ

diameter..... *S. barcinonensis*

- Sterile cells in groups or chains, angular, 7–15 μ diameter *S. Duthiei*
 Sterile cells usually in pairs, about 15 μ diameter *S. tonkinensis*
 Spores 11–16 μ diameter.
 Spores subglobose, often angled *S. occidentalis*
 Sori 1–5 cm. long and over.
 Spores 3–8 μ diameter.
 Sterile cells rectangular, in chains, spores vacuolate *S. Milbraedii*
 Spores 8–16 μ diameter,
 Spores smooth.
 Spores small, 7–12 μ diameter . . . *S. Seymouriana*
 Spores large, 11–14 μ diameter . . *S. guaranitica*
 Spores echinulate or verruculose.
 Spores thick-walled.
 Sterile cells collapsed, in rows *S. Stuhlmanii*
 Sterile cells not collapsed . . . *S. Schoenanthi*
 Spores thin-walled.
 Spores reddish brown *S. monilifera*
 Spores olive brown *S. Warneckiana*
 Sori involving the entire inflorescence.
 Sori 1 cm. or less.
 Spores 5–10 μ diameter.
 Sterile cells rectangular, spores light reddish brown *S. Nardi*
 Sterile cells evanescent *S. tenuis*
 Sterile cells globose, large.
 Spores smooth, banded *S. concentrica*
 Spores minutely echinulate *S. Ritchiei*
 Spores 10–16 μ diameter.
 Columella simple.
 Spores dark reddish brown *S. superflua*
 Spores light reddish brown *S. natalensis*
 Columella branched, rootlike *S. transvaalensis*
 Sori 1–5 cm. long.
 Spores 5–12 μ diameter.
 Spores vacuolated *S. columellifera*
 Spores verruculose.
 Spores 5–8 μ , rarely 10 μ *S. congensis*
 Spores 7–12 μ *S. bicornis*
 Spores smooth.
 Spores thick-walled, often angled *S. Dinteri*
 Spores regular, globose.
 False membrane light colored *S. Lanigeri*
 False membrane brown *S. Andropogonis*
 Spores echinulate, 7–10 μ *S. Zilligii*
 Spores 10–16 μ diameter.
 Spores elongated with evident granular verruculations *S. Kellermanii*

- Spores less elongated with less evident granular verruculations *S. Hohwayi*
 Spores 13–21 μ and over. *S. culmiperda*
 Sori 5–9 cm. and over.
 Sterile cells rectangular, in chains, tinted brown. *S. leucostachys*
 Sterile cells globose, in groups, hyaline. . . *S. Andropogonis-hirtifolii*

1. *Sphacelotheca Moggii* Zundel, n. sp.

Sori in the inflorescence, long linear, 5–10 mm. long, single or in groups attacking individual flowers, usually hidden at first by the outer leaf sheath, often protruding later, covered with a sterile tissue which flakes away revealing a dark brown agglutinated spore mass surrounding a well developed, often forked, columella.

Sterile tissue very fragile and "tissue like," somewhat effervescent and adhering more or less to the outside of the sori, breaking up into groups or balls of sterile cells, which are tinted brown, vacuolated with granular contents, 7–12 μ diameter; the sterile cell spore balls, with 4 or more spores, 15–22 μ in diameter, globose-subglobose; balls of sterile cells are also scattered throughout the sorus.

Spores tinted olive brown to almost hyaline, vacuolated, globose-subglobose, regular, ranging from 4–6 μ diameter, smooth under oil immersion.

On *Andropogon plurinodis* (*Cymbopogon plurinodis*): Armoeds Vlatte, British Bechuanaland, Union of South Africa, coll. A. O. D. Mogg, August 28, 1924 (U. D. Agr. Myc. Herb. 19859).

This species is closely related to *S. cruenta* in having the large globose balls of sterile cells but differs in the size of the sorus, in the texture of the outer false membrane, and in the color of the spores. May be parent of *S. cruenta*.

2. *SPHACELOTHECA FURCATA* Pat. & Hariot, in litt.

Ustilago furcata Pat. & Hariot, Jour. Bot. (France) 14: 230. 1900.

Sori entirely destroying the ovaries, partially concealed by the glumes but elongated, 8–12 mm., and later protruding between the glumes. Covered by a false membrane which is easily broken up into rather irregular globose to oblong sterile cells with an outer hyaline area and an inner light brown area, 9–12 μ in diameter.

Spores regular, globose, smooth, dark reddish brown, 5–7 μ , in mass forming a dark brown powder.

On *Andropogon* sp.: French West Africa.

3. *Sphacelotheca Doidgeae* Zundel, n. sp.

Sori in the inflorescence usually involving the entire spikelet along the rachis, long linear, frequently irregularly branched or compound, 3–8 mm. long, covered by an evident, thick brown false membrane, which dehisces from the apex disclosing a brown agglutinated mass of spores surrounding a well developed irregular columella.

Evident sterile tissue breaking up into groups or chains of hyaline sterile cells, 6–10 μ diameter; groups of large globose sterile cells throughout the sori; rather persistent sterile tissue.

Spores globose-subglobose, thick walled, olivaceous, smooth and finely granular under oil immersion, 6–10 μ diameter.

On *Andropogon* sp.: Edendale, Natal, Union of South Africa, coll. E. M. Doidge, December 26, 1911 (U. D. Agr. Myc. Herb. 1997). *Andropogon intermedius*: Maritzburg, Natal, Union of South Africa, coll. J. M. Sim, March 15, 1915 (U. D. Agr. Myc. Herb. 8939). *Andropogon appendiculatus*: Onderspoort, Pretoria, Union of South Africa, coll. A. O. D. Mogg, February 20, 1921 (U. D. Agr. Myc. Herb. 15058).

4. *Sphacelotheca sorghicola* (Speg.) Zundel, n. comb.

Ustilago sorghicola Speg. Anal. Mus. Nac. Buenos Aires III. 1: 58. 1902.

Sori destroying the ovaries, hypertrophied, 4–6 mm. long, covered by an evident false membrane which flakes away revealing a dark brown spore mass surrounding a well developed columella. Spores 4.5–6 μ diameter, reddish brown, with an evident hyaline center, globose-subglobose, regular, smooth under oil immersion; sterile cells singly or in short chains, hyaline, globose to subglobose, sometimes angular, 3–9 μ diameter.

On *Andropogon Sorghum*: Argentina; Malta; Formosa.

5. *SPHACELOTHECA CRUENTA* (Kuhn) Potter, Phytopath. 2: 98. 1912.

Ustilago cruenta Kuhn, Hamburg Gart. Blumenztig. 28: 177–178. 1875.

Sori destroying the ovaries, which are scarcely larger than normal, covered with an evident membrane which breaks up into globose cells; groups of large globose cells scattered throughout the sori; as the false membrane flakes away a brown granular spore mass is revealed surrounding a long curved, well developed

columella; sterile cells hyaline, globose-subglobose, singly or in groups, 9–14 μ diameter; spores globose-subglobose, light reddish brown, smooth, 5–8 μ diameter.

On *Andropogon halepense*: Anatolia; Tanganyika Territory.

Andropogon Sorghum (*Sorghum vulgare*) (*S. saccharatus*): United States (Texas, Wisconsin); Cuba; Haiti; Jamaica; Asia Minor; India.

6. *SPHACELOTHECA SORGHI* (Link) Clinton, Jour. Myc. 8: 140. 1902.

Sorosporium Sorghi Link, in Willd. Sp. Pl. 6²: 86. 1825.

Sori destroying the ovaries, which are elongated about twice the normal length of the seed, covered with an evident false membrane which ruptures, revealing a brown spore mass surrounding a short, thick, well developed columella; false membrane usually breaking up into chains of small hyaline cells, subglobose-ellipsoidal, 3–10 μ diameter; spores reddish brown, globose-subglobose, smooth, 3–8 μ diameter, mostly about 5 μ diameter.

On *Andropogon halepensis*: Cuba; India; Mesopotamia; Turkestan. *Andropogon halepensis muticus*: Italy; Caucasia (Georgia); Turkestan. *Andropogon Sorghum* (*Sorghum vulgare*): United States (Alabama, California, Connecticut, District of Columbia, Illinois, Indiana, Iowa, Kansas, Nebraska, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Dakota, Utah, Washington, Wisconsin); Canada (Manitoba, Ontario); Cuba; Jamaica; Porto Rico; Argentina; Czechoslovakia; Denmark; Germany; Great Britain (Kew Bot. Garden); Holland; Hungary; Italy; Malta; Roumania; Russia; Spain; Yugoslavia; Abyssinia; Algeria; Egypt; French Congo; Senegal; Soudan; Tanganyika Territory; Union of South Africa; Kenya Protectorate; Caucasia (Georgia); Japan; Philippine Islands; Australia. *Andropogon* (*Sorghum*) sp.: United States (Hawaii); Erythraea; Gold Coast; Kenya Protectorate; Turkestan.

7. *Sphacelotheca Andropogonis-annulati* (Bref.) Zundel, n. comb.

Ustilago Andropogonis-annulati Bref. Unters. Gesamt. Myk. 12: 109. 1895.

Sori destroying the ovaries, about 3 mm. long, at first hidden by the glumes but later protruding by forcing the glumes apart,

covered by an evident false membrane with evanescent sterile cells; spores globose-subglobose, reddish brown, under oil immersion vacuolated, indistinctly echinulate, usually 8–9 μ diameter, but ranging 7–12 μ diameter.

On *Andropogon annulatus*: India.

8. *Sphacelotheca Evansii* Zundel, n. sp.

Sori in the inflorescence, long linear, 5–10 mm. long, inconspicuous, hidden by the glumes, covered by an evident membrane which when broken discloses a dark brown spore mass surrounding a well developed columella.

Groups of sterile cells throughout the sorus; false tissue rather permanent, breaking up into large groups of chains of sterile cells; sterile cells hyaline, irregular, globoid, 9–12 μ diameter.

Spores olivaceous brown, globose-subglobose, regular, usually 8–10 μ , under oil immersion smooth and vacuolated.

On *Andropogon* sp. (*Cymbopogon* sp.): Olifants River, Transvaal, Union of South Africa, coll. I. B. Pole Evans, January 1, 1918 (U. D. Agr. Myc. Herb. 14174).

9. *Sphacelotheca Nyassae* (H. & P. Sydow) Zundel, n. comb.

Ustilago Nyassae H. & P. Sydow, Ann. Myc. 18: 156. 1920.

Sori destroying the ovaries, which remain about normal size, 5 mm. long, inconspicuous, concealed by the glumes, covered by an evident false membrane which ruptures, revealing a brown powdery spore mass surrounding a simple columella; false membrane breaking up into hyaline, globose sterile cells, 11–16 μ diameter; spores globose-subglobose, sometimes angular, reddish brown, under oil immersion coarsely vacuolated, finely verruculose, 9–12 μ diameter

On *Andropogon* sp.: Nyassaland Protectorate, Africa.

10. *SPHACELOTHECA BARCINONENSIS* Fz.-Riöf. Bol. Real Soc. Esp. Hist. Nat. 23: 193. 1923.

Sori destroying the ovaries, concealed by the floral glumes; infected ovaries slightly larger than normal, at first inconspicuous, covered with an evident false membrane which breaks up into globose sterile cells usually in groups or chains, hyaline, 7–12 μ diameter; spores light reddish brown, globose-subglobose, somewhat irregular, contents appearing as if full of oil drops (vacuolated), indistinctly verruculose under oil immersion, 9–12 μ diameter.

On *Andropogon hirtus* var. *longiaristatum*: Spain.

11. *Sphacelotheca Duthiei* (Ricker) Zundel, n. comb.

Ustilago Duthiei Ricker, Jour. Myc. 11: 111. 1905.

Sori in the ovaries, which are scarcely enlarged, inconspicuous, hidden by the glumes, 2–3 mm. long and covered by a false membrane which is more or less evanescent, breaking up into groups or chains of cells or into individual cells which are globose-subglobose, often angular, irregular, hyaline, 7–15 μ diameter; spores yellowish brown, globose-subglobose, regular, verruculose under oil immersion, 9–12 μ diameter.

On *Andropogon annulatus* (*A. Bladhii*): India.

12. *Sphacelotheca tonkinensis* (P. Henn.) Zundel, n. comb.

Uredo tonkinensis P. Henn. Hedwigia 34: 11. 1895.

Sori destroying the ovary, 2–3 mm. long, at first concealed by the glumes, covered by a brown false membrane, which dehisces from the apex revealing a brown spore mass surrounding a well developed columella. Spores globose-subglobose, regular, with a thick double wall, reddish brown, the inner part of the spore granular-vacuolate, 9–12 μ diameter, smooth under oil immersion. Sterile cells hyaline, globose, usually in pairs, each pair about 15 μ diameter.

On *Andropogon* sp.: Philippine Islands; Tonkin.

This species is described as *Uredo tonkinensis* P. Henn. in Hedwigia 34: 11. 1895. Saccardo lists it as *Uredo tonkinensis* P. Henn. in Syll. Fung. 11: 232. 1895, with the genus *Ustilago*, and lists it in the index as *Ustilago tonkinensis* P. Henn.

13. *SPHACELOTHECA OCCIDENTALIS* (Seym.) Clinton, Jour. Myc. 8: 141. '1902.

Sorosporium Ellisii occidentalis Seym. in Ellis & Everh. N. A. Fung. 2265. Feb. 1889.

Sori in the ovary, linear, $\frac{1}{2}$ –1 cm. long, covered by an evident false membrane which dehisces from the apex disclosing a powdery mass of spores surrounding an evident, well developed columella; sterile cells hyaline, very variable in size and shape, 7–14 μ diameter, globose-subglobose or rectangular; due to partial gelatinization of false membrane the cells are frequently rather indistinct; spores reddish brown, subglobose, often angled, variable in shape, sometimes mechanically hanging together in clusters but not forming spore balls, minutely verruculose under oil immersion, 11–16 μ diameter.

On *Andropogon Hallii*: United States (Kansas, Nebraska).
Andropogon macourus: United States (California). *Andropogon*
provincialis (*A. furcatus*): United States (Kansas, Nebraska,
 North Dakota).

14. **Sphacelotheca Milbraedii** (H. & P. Sydow) Zundel, n. comb.

Ustilago Milbraedii H. & P. Sydow, Wissensch. Ergebn.
 Deutsch. Zentral Exped. 1907-1908: 95. 1911.

Sori in the ovaries, long linear, 3-5 cm., covered with an evident false membrane which flakes away disclosing a semi-powdery spore mass with a well formed columella: outer false membrane rather persistent, breaking up into large groups of cells; sterile cells tinted brown, rectangular and in rows; balls of sterile cells throughout the sorus, tinted brown, subglobose, 9-12 μ diameter; spores irregular, globose-subglobose and sometimes cubical, angled, flattened, tinted brown, with a darker colored oil drop in the center, faintly echinulate under the oil immersion, thin-walled, 3-8 μ diameter.

On *Andropogon Schoenanthus*: Tanganyika Territory, Africa.

15. **SPHACELOTHECA SEYMOURIANA** Clinton, Proc. Boston Soc.
 Nat. Hist. 31: 387. 1904.

Sori in the ovary, entirely destroying the floral parts, hidden by the glumes, linear, about 5-7 cm. long or about same length as glumes, covered by an evident membrane which ruptures from the apex disclosing a more or less agglutinated spore mass. Sterile cells scattered throughout the sorus and also composing the outer false membrane, not easily broken into individual cells but hanging together in clusters (especially in outer membrane) of six or more cells, more or less globose, those in outer tissue more irregular, 7-12 μ diameter; spores brown, globose-subglobose, occasionally oblong, angular, sometimes pitted, smooth, 7-12 μ diameter.

On *Andropogon virginicus*: United States (Alabama, North Carolina). *Andropogon* sp.: United States (Georgia).

16. **Sphacelotheca guaranitica** (Speg.) Zundel, n. comb

Ustilago guaranitica Speg. Anal. Soc. Cien. Argentina 17: 87.
 1884.

Sori in the ovaries, 2-3 cm. long, completely destroying inflorescence, surrounded by an evident false membrane which upon rupturing discloses a dark brown spore mass surrounding a simple columella; spores smooth, rather regular, globose-

subglobose, 11–14 μ in diameter, yellowish brown; false membrane easily broken up into individual, hyaline, globose-subglobose cells, 7–11 μ diameter (Rab. Fungi Europ. 4006).

On *Andropogon condensatus*: Paraguay; Venezuela. *Andropogon* sp.: Venezuela.

17. **Sphacelotheca Stuhlmanni** (P. Henn.) Zundel, n. comb.

Ustilago Stuhlmanni P. Henn. Bot. Jahrb. (Engler) 17: 3. 1893.

Sori in the ovaries, destroying the inflorescence, long linear, usually 7–10 cm. long and covered with an evident brown membrane which flakes off disclosing a brown, more or less agglutinated spore mass; sterile tissue tinted brown, breaking up into large groups of cells; the sterile cells in rows; cells often collapsed; spores globose-subglobose, thick-walled, sometimes angular, minutely echinulate under oil immersion, reddish brown, 9–14 μ diameter.

On *Andropogon* sp.: Central Africa; Tanganyika Territory.

18. **Sphacelotheca Schoenanthi** (H. & P. Sydow & Butler) Zundel, n. comb.

Ustilago Schoenanthi H. & P. Sydow & Butler, Ann. Myc. 4: 425 1906

Sori destroying the ovaries, long linear, about 1 cm. long, surrounded by a false membrane which flakes away revealing a brown, semi-agglutinated spore mass and a well formed columella, at first hidden by the sheath; sterile tissue breaking up into large hyaline, globose-subglobose cells, 11–16 μ diameter; spores regular, globose-subglobose, reddish brown, thick-walled, minutely echinulate under oil immersion, 8–14 μ diameter.

On *Andropogon Schoenanthus*: India.

19. **SPHACELOTHECA MONILIFERA** (Ellis & Ev.) Clinton, Jour. Myc. 8: 141. 1902.

Ustilago monilifera Ellis & Ev. Bull. Torrey Club 22: 362. 1895.

Sori in the ovaries, elongate, often concealed by the glumes, 4–7 mm. long or about the same length as the glumes, covered by rather persistent false membrane which flakes away disclosing a more or less agglutinated brown spore mass and a well developed columella; sterile cells the same size as spores, globose-subglobose, sometimes angled, with a light brownish tint; spores reddish brown, globose-subglobose, sometimes angled, inclined to

collect in groups but not in spore balls, verruculose, 9–12 μ diameter.

On *Andropogon contortus* (*Heteropogon contortus*): United States (Arizona, Hawaii); Mexico; Tanganyika Territory.

20. *Sphacelotheca Warneckeana* (P. Henn.) Zundel, n. comb.

Ustilago Warneckeana P. Henn. Bot. Jahrb. (Engler) 38: 119. 1905.

Sori in ovaries, long linear, 3–5 mm. long, at first hidden by the glumes, covered by an evident membrane which ruptures disclosing a brown spore mass and a simple or much branched columella; sterile tissue more or less permanent, tinged brown, breaking up into clusters of cells or individual cells; sterile cells globose-subglobose, about the size of the spores; spores olivaceous-reddish brown, globose-subglobose, often irregular, abundantly echinulate, 9–12 μ diameter.

On *Andropogon contortus* (*Heteropogon contortus*): Camerun, Africa; India.

21. *Sphacelotheca Nardi* (H. & P. Sydow) Zundel, n. comb.

Ustilago Nardi H. & P. Sydow, Ann. Myc. 4: 425. 1906.

Sori in the inflorescence, long linear, about 2–3 mm. long, inconspicuous, covered with a delicate false membrane which flakes away revealing a brown spore mass and a well developed columella, nearly concealed by the floral sheath; false membrane breaking up into groups or chains of rectangular sterile cells, tinted brown, about 5 \times 6 μ diameter; spores globose-subglobose, irregular, light reddish brown, smooth, 5–8 μ diameter.

On *Andropogon Nardus*: India.

22. *Sphacelotheca tenuis* (H. & P. Sydow) Zundel, n. comb

Ustilago tenuis H. & P. Sydow, Ann. Myc. 4: 425. 1906.

Sori $\frac{1}{2}$ –1 cm. long, destroying the inflorescence, covered with a false membrane which is more or less permanent but when broken reveals a more or less semi-powdery spore mass surrounding a well developed columella; the cells of the sterile tissue fuse and to a large degree lose their cellular structure, appearing as a more or less amorphous mass; some globose cells, however, retain their identity; spores olive brown, globose-subglobose, somewhat irregular and angular, thick-walled, finely granular under oil immersion, smooth, 6–10 μ diameter.

On *Andropogon pertusus*: India.

23. *Sphacelotheca concentrica* Zundel, n. sp.

Sori in the inflorescence, broadly elongate, 1 cm. or less in length, at first concealed by the subtending bracts, surrounded by an evident light colored false membrane which flakes away revealing a partially agglutinated dark spore mass surrounding a well formed columella.

Sterile tissue breaking up into hyaline globose cells, variable in size, ranging from 10–21 μ diameter

Spores globose-subglobose; under oil immersion the spore is divided into four concentric parts, an outer dark brown area, then a light reddish brown area, and an inner vacuolated, light colored area surrounded by a second dark brown area, smooth, 4–8 μ diameter, usually 6–8 μ diameter.

On *Andropogon plurinodis* (*Cymbopogon plurinodis*): Pretoria, Union of South Africa, coll. A. O. D. Mogg, November 1, 1917 (U. D. Agr. Myc. Herb. 10708).

24. *Sphacelotheca Ritchiei* Zundel, n. sp.

Sori in the inflorescence, long linear, 5–8 mm. long; sori gregarious, at first hidden by the glumes, later the upper ends protruding, covered by an evident dark brown false membrane which flakes away from the apex revealing a brown spore mass surrounding a well developed columella.

Sterile cells hyaline, singly, in pairs, in short chains or groups (usually in pairs), usually larger than the spores, ranging from 9–15 μ diameter, usually 9–12 μ , with the largest single cells 15 μ diameter, thin-walled and somewhat fragile.

Spores globose-subglobose, reddish brown, regular, under oil immersion minutely verruculate, 6–10 μ diameter.

On *Andropogon* sp. (*Hyparrhenia cymbaria*): Morogoro, Tanganyika Territory, coll. A. H. Ritchie, January, 1926 (U. D. Agr. Myc. Herb. 20650).

25. *Sphacelotheca superflua* (H. & P. Sydow) Zundel, n. comb.

Ustilago superflua H. & P. Sydow, Ann. Myc. 10: 249. 1912.

Sori destroying the inflorescence, long linear, 5–8 mm. long, covered by an evident brown false membrane which flakes away revealing a dark brown spore mass surrounding a well developed columella, at first concealed by the sheath but later entirely protruding; false membrane breaking up into globose sterile cells, faintly tinted brown, 11–16 μ diameter; spores deep reddish brown, subopaque, globose-ellipsoidal, somewhat irregular and frequently annulate, echinulate under oil immersion. 11–16 μ diameter.

On *Andropogon foveolatus*: India.

26. *Sphacelotheca natalensis* Zundel, n. sp.

Sori in the inflorescence, long linear, 3–6 mm. long, covered by an evident brown false membrane which flakes away revealing an agglutinated spore mass surrounding a well developed simple columella.

Sterile cells globose, mostly hyaline, usually in groups or short chains, variable in size, 12–15 μ diameter, reddish brown en masse.

Spores light reddish brown, globose-subglobose, thin-walled, under the oil immersion smooth, 10–12 μ diameter.

On *Andropogon* sp.: Mooi River, Natal, Union of South Africa, coll. A. O. D. Mogg, September 4, 1917 (U. D. Agr. Myc. Herb. 11705).

27. *Sphacelotheca transvaalensis* Zundel, n. sp.

Sori destroying the inflorescence, long, broadly linear, 5–10 mm., surrounded by a heavy dark brown false membrane which flakes away revealing a mass of black spores surrounding a large well developed root-like, branched central columella and many surrounding smaller columellae. (Resembling a small root system of an herbaceous plant.)

Sterile cells globose-subglobose, hyaline, delicate, large, ranging from 11–12 μ diameter, individual or in short chains.

Spores globose-subglobose, reddish brown, regular in size, under the oil immersion smooth with finely granular contents, 10–12 μ diameter.

On *Andropogon* sp. (*Sorghum* sp.): Onderste Poort, Pretoria, Transvaal, Union of South Africa, coll. A. O. D. Mogg, January 23, 1919 (U. D. Agr. Myc. Herb. 17047).

28. *SPHACELOTHECA COLUMELLIFERA* (Tul.) Ciferri, Ann. Myc. 26: 32. 1928.

Cintractia columellifera (Tul.) McAlp. Smuts of Austral. 166. 1910.

Sori destroying the inflorescence, long linear, 5–7 cm., at first concealed by the sheath but later protruding, covered by an evident yellowish white false membrane which ruptures irregularly revealing a dark brown agglutinated spore mass surrounding a large well developed, hollow columella; false membrane breaking up into groups or chains of globose, hyaline, sterile cells, 7–12 μ diameter; spores generally globose, regular,

occasionally subglobose, light reddish brown, under oil immersion vacuolated contents, smooth, mostly $7\ \mu$ diameter, sometimes as high as $9\ \mu$.

On *Andropogon australis*: Australia. *Andropogon hirtus* (*Heteropogon hirtus*): Algeria; Madeira Islands; Tanganyika Territory. *Pennisetum cenchroides*: Algeria; Madeira Islands.

29. *SPHACELOTHECA CONGENSIS* (H. & P. Sydow) Wakefield, in litt.

Ustilago congensis H. & P. Sydow, in Wildeman, Etude Fl. Bas.- et Moyen-Congo, I. 3: 9. 1909.

Sori destroying the inflorescence, long linear, 1–2 cm. long, grouped together, producing a witches' broom effect, at first hidden by the bracts subtending the panicle, covered by an evident thick false membrane more or less persistent breaking up into groups or chains of sterile cells which adhere rather firmly; sterile cells hyaline, thick-walled, globose-broadly ellipsoidal, $7\text{--}10\ \mu$ diameter and up to $14\ \mu$ long for the ellipsoidal cells; spores medium to light reddish brown, globose-subglobose, sometimes broadly ellipsoidal, somewhat irregular as to size, mostly $5\text{--}8\ \mu$ or rarely up to $10\ \mu$ diameter, minutely verruculose under oil immersion (Ex-Herb. Hort. Bot. Reg. No. 3056 & 4412).

On *Andropogon* sp.: Congo.

30. *Sphacelotheca bicornis* (P. Henn.) Zundel, n. comb.

Ustilago bicornis P. Henn. Hedwigia 35: 50. 1896.

Sori in the inflorescence, long linear, forming a witches' broom growth, covered with an evident reddish brown false membrane, 1–2 cm., destroying nearly all of the inflorescence; numerous sori grouped together at point of the development of inflorescence; sterile tissue surrounding the sori which breaks up into subglobose sterile cells which frequently hold together in groups, about the size of the spores, sometimes tinted brown; spores light reddish brown, rather irregular, globose-ellipsoidal, often angular, verruculose under oil immersion, $7\text{--}12\ \mu$ diameter.

On *Andropogon bicornis*: Brazil.

31. *Sphacelotheca Dintieri* (H. & P. Sydow) Zundel, n. comb.

Ustilago Dintieri H. & P. Sydow, Ann. Myc. 13: 37. 1915.

Sori destroying the entire inflorescence, almost entirely hidden by the terminal sheath, long linear, 2–4 cm. long, covered by an evident brown false membrane which flakes away revealing a

semi-powdery, brown spore mass surrounding a well formed columella; sterile tissue composed of globose cells, faintly tinted brown, breaking up into groups of cells or into individual cells 7–12 μ diameter, globose-subglobose, sometimes ellipsoidal; spores olive brown, globose-subglobose, sometimes ellipsoidal, frequently angled, thick-walled, finely granular, smooth, 9–12 μ diameter.

On *Andropogon papillosus*: South West Africa.

32. SPHACELOTHECA LANIGERI (Magn.) Maire, in litt.

Ustilago Lanigeri P. Magn. Verhandl. Zool.-Bot. Gesell. Wien 49: 88. 1899.

Sori almost completely hidden within the glumes, covered by an evident false membrane which splits longitudinally disclosing a dark brown spore mass, completely destroying the inner floral parts, about 1–1½ cm. long; false membrane adhering rather firmly in groups and rarely breaking into individual cells; sterile cells irregular in size and shape globose-subglobose, sometimes angular, 8–18 μ diameter; spores globose, regular, reddish brown, smooth, 5–8 μ diameter, occasionally 12 μ .

On *Andropogon laniger*: Morocco; Persia.

33. SPHACELOTHECA ANDROPOGONIS (Opiz) Bubak, Naturw. Landes. Böhmen. 15: 25. 1916.

Sphacelotheca Ischaemi (Fuckel) Clinton, Jour. Myc. 8: 140. 1902.

Sori usually involving entire inflorescence, long linear, hidden by sheath, 10–40 mm. long, 1–4 mm. wide, covered with a false membrane which flakes away disclosing a brown spore mass and a well developed columella; false membrane rather permanent, breaking up into large masses of tissue rather than individual cells; sterile tissue also scattered throughout the sori; sterile cells globose-subglobose, flattened when in contact with each other, 7–16 μ diameter, usually hyaline or tinted brown en masse; spores medium reddish brown, globose-subglobose, smooth and minutely granular, 8–11 μ diameter.

On *Andropogon contortus* (*Heteropogon contortus*): United States (Arizona); Mexico; Erythrea; Philippine Islands. *Andropogon distachyos*: France; Spain. *Andropogon foveolatus*: Egypt. *Andropogon furcatus*: United States (Kansas). *Andropogon halepensis*: Philippine Islands. *Andropogon hirtus*: Czechoslovakia; Spain; Congo. *Andropogon hirtus longiaristata*: Spain. *Andropogon hirtus pubescens*: Spain; Anatolia (Smyrna). *Andropogon*

Ischaemum: Austria; Bulgaria; Germany; Greece; Poland; Roumania; Spain; Switzerland; Yugoslavia (Serbia); Congo; Persia. *Andropogon Ischaemum longiaristatum*: Czechoslovakia; Hungary; Italy; Spain. *Andropogon Iwarancusa* (*A. proximus*): Erythrea. *Andropogon pubescens*: Malta; Congo; Tunis; Syria; Palestine. *Andropogon saccharoides*: Mexico. *Andropogon scoparius*: United States (Illinois). *Andropogon Torreyanus*: United States (Arizona, Texas). *Andropogon* sp.: United States (Arizona) Czechoslovakia; Central Africa; Congo; Tanganyika Territory; Tripoli; Union of South Africa. *Cymbopogon excavatus*: Union of South Africa. *Ischaemum timorense*: tropical Africa. *Pennisetum dichotomum*: Egypt.

34. *Sphacelotheca Zilligii* Zundel, n. sp.³

Sori in the inflorescence, solitary, long linear, 1–3 cm. long, at first concealed by the sheath, covered by an evident brown false membrane which flakes away revealing a dark brown granular spore mass surrounding a well developed much branched columella.

Sterile cells globose-subglobose, hyaline, usually adhering in groups or chains, angular by compression—variable in size, ranging from 8–14 μ diameter.

Spores globose-subglobose, semi-regular, light reddish brown, medium echinulate under the oil immersion, 7–10 μ diameter.

On *Andropogon* sp.: Stryberg, Union of South Africa, coll. A. O. D. Mogg, March 25, 1921 (U. D. Agr. Myc. Herb. 20666).

35. *Sphacelotheca Kellermanii* Clinton & Zundel, n. sp.

Sori in the inflorescence, bunched and forming a witches' broom effect but individual sori linear-elongated, usually 2–4 cm. in length; sterile membrane conspicuous, breaking irregularly into elongated strips (disclosing dusty spore mass and eventually the elongated recurved columella of plant tissues) but not separating easily into the individual cells (hyaline to reddish brown tinted), which are chiefly oblong to cubical and smaller than the spores; spores dark reddish brown, subopaque, angular, irregularly oblong to subspherical, evidently granular-verruculose under immersion lens, 10–16 μ , rarely 18–20 μ , in length.

On *Andropogon leucostachyus*: Guatemala, Central America.

This species is closely related to *Sphacelotheca Holwayi* on *Andropogon bicornis* but differs in the occasionally more elongated

³ Named for Dr. Hermann Zillig, German Ustilaginologist.

spores and in the more evident granular verruculations. It is even more distinct from *Sphacelotheca* (*Ustilago*) *leucostachys* on the same host since the latter has quite regular subspherical, larger spores and a simple sorus. This description is based on three collections made by W. A. Kellerman in Los Amates, Guatemala, March 15, 1905, January 15 and February 15, 1908. The host was determined by Agnes Chase.

36. *Sphacelotheca* *Holwayi* Clinton & Zundel, n. sp.

Sori in the inflorescence, bunched and forming witches' broom effect with individual sori linear-elongated, usually 2-4 cm. in length; sterile membrane conspicuous, breaking irregularly into elongated strips (disclosing spore mass and eventually elongated recurved remains of plant tissue) but not separating easily into the individual, hyaline (with age tinted reddish brown) cells which are chiefly oblong to cubical and smaller than the spores; spores dark reddish brown, subopaque, angular, irregularly oblong to subspherical, obscurely granular-verruculose under immersion lens, 10-16 μ , or most elongated rarely 18 μ in length.

On *Andropogon bicornis*: Bolivia, South America.

Closely related to *Sphacelotheca Kellermanii* on *Andropogon leucostachys*, collected by Kellerman in Guatemala (nos. 7601, 6501a, 7252. U. S. Dept. Agr. Herb.) but differs in the less elongated spores and less evident granular verruculations but otherwise similar and from *Sphacelotheca culmiperda* on same host, *Andropogon bicornis*, even more through the witches' broom-like sorus and the more irregular and smaller spores. *Ustilago* (*Sphacelotheca*) *bicornis*, also on *Andropogon bicornis*, has a similar compound sorus with witches' broom effect but the spores are decidedly smaller and lighter colored. We find no species it agrees with exactly and so have described it as new. This description is based on a collection (in Clinton Herbarium) by W. E. D. and Mary M. Holway (Plants S. A. no. 686) made May 31, 1920, at Villa Aspiazu, Provincia de sur Yungas, Bolivia. The host was determined by Dr. A. S. Hitchcock.

37. *Sphacelotheca culmiperda* (Schröt.) Clinton, n. comb.

Ustilago culmiperda Schröt. *Hedwigia* 35:212. 1896.

Sori destroying the floral parts, long linear, 3-6 cm. long, at first hidden by the terminal leaf sheath but later more or less exposed, covered by an evident dark brown membrane which

flakes off revealing a brown spore mass surrounding a well developed columella. Sterile tissue more or less permanent, breaking up into chains of cells; sterile cells reddish brown, subglobose to ellipsoidal. The subglobose cells scattered throughout the sorus as short chains of cells and about the size of the spores; the cells of the outer false tissue more elongate and angular, about $5-13\ \mu$; spores deep reddish brown, subopaque, globose-subglobose or flattened ellipsoidal due to an appression on one side, regular, under oil immersion lens abundantly verruculose and granular, $13-19\ \mu$ diameter.

On *Andropogon bicornis*: Brazil. *Andropogon* sp.: Brazil.

38. *Sphacelotheca leucostachys* (P. Henn.) Zundel, n. comb.

Ustilago leucostachys P. Henn. Hedwigia 35: 50. 1896.

Sori in the inflorescence, long linear, 5-7 cm. long, at first concealed by the sheath but later protruding as a long, linear, curled body, covered with a light brown false membrane which flakes away revealing a brown spore mass surrounding a long thick well developed columella extending the length of the sorus; false membrane composed of rectangular cells in chains which break up either singly or adhere in chains, tinted brown, $9-14 \times 5-7\ \mu$; spores dark reddish brown, globose-subglobose, regular, opaque, obscurely but abundantly, minutely verruculose under oil immersion, $13-17\ \mu$ diameter.

On *Andropogon leucostachys*: Brazil.

39. *SPHACELOTHECA ANDROPOGONIS-HIRTIFOLII* (P. Henn.) Clinton, Jour. Myc. 8: 141. 1902.

Ustilago Andropogonis-hirtifolii P. Henn. Bot. Gaz. 28: 274. 1899.

Sori destroying the entire inflorescence and occupying more or less of the entire panicle, forming large irregular bodies, 5-9 cm. long, at first hidden by the sheath, covered by an evident false membrane which gradually flakes away disclosing a more or less agglutinated brown spore mass which gradually becomes powdery; false membrane breaking up into groups of cells rather than individual cells; groups of sterile cells throughout the sorus, hyaline, globose-subglobose, $7-13\ \mu$ diameter; spores globose-subglobose, sometimes angled, reddish brown, minutely verruculose under oil immersion, $9-14\ \mu$ diameter.

On *Andropogon hirtifolius pubiflorus*: Mexico. *Andropogon saccharoides*: United States (Arizona).

SOROSPORIUM Rud. Linnaea 4: 116. 1829

- Sori on the leaves. *S. Wildemanianum*
- Sori in the inflorescence.
- Sori less than 1 cm. long.
- Spores with thick yellowish walls, vacuolated. *S. pretoriaense*
- Spores light reddish brown.
- Spore balls 50–114 μ diameter *S. Holstei*
- Spore balls 142–190 μ diameter *S. austro-africanum*
- Sori 1–3 cm. long.
- Spores small, 7–12 μ diameter.
- Spore balls small, 40–70 μ *S. Healdii*
- Spore balls large, 50–125 μ *S. Everhartii*
- Spores large, 9–16 μ or more diameter.
- Spores papillate. *S. filiferum*
- Spores verruculose. *S. Ellisii*
- Spores echinulate.
- Spores irregular, angled. *S. tumefaciens*
- Spores regular.
- Spore balls with 10–20 spores. *S. icosiense*
- Spore balls with many spores.
- Sori hypertrophied, 5–7 mm. thick. *S. Ehrenbergii*
- Sori long, linear. *S. Tembuti*
- Sori more than 3 cm. long.
- Sori irregular, causing destruction of either male or female inflorescence.
- Spore balls 45–60 μ diameter, permanent. *S. proliferatum*
- Spore balls 75–150 μ diameter, temporary. *S. Reilianum*
- Sori regular.
- Spores 11–20 μ diameter.
- Spores globose-subglobose. *S. provinciale*
- Spores angled. *S. geminellum*
- Spores 8–10 μ , echinulate *S. Hodsonii*
- Sori tubular, stuffed with spores. *S. filiformis*
- Sori not tubular.
- Spores verruculose.
- Sori clustered as a "witches' broom". *S. Clintonii*
- Sori single, long linear.
- Spores dark brown to hyaline. *S. contortum*
- Spores light yellowish brown. *S. maranguense*
- Spores pitted. *S. Heteropogonis-contorti*⁴
- Sori solitary, large, 5–6 mm. wide. *S. harrismithense*

Spores echinulate.

With large internal, hyaline balls of sterile cells. *S. Simii*

Without internal balls of sterile cells.

Spores ranging from reddish

brown to hyaline. *S. caledonicum*

Spores even colored, dark reddish brown . . . *S. Flanaganianum*

Spores globose-angular . . . *S. dembianense*⁴

Spores smooth.

Spores 4–6 μ diameter. . . *S. Andropogonis-aciculati*

1. *Sorosporium WILDEMANIANUM* P. Henn. Ann. Mus. Congo V. 2: 87. 1907.

Sori on the leaves occurring as small erumpent pustules covered with the epidermis, which upon rupturing discloses a dark brown spore mass; spore balls opaque, dark reddish brown, 50–80 spores, ellipsoidal-subellipsoidal, 70–114 μ diameter; spores fragile, dark reddish brown, minutely echinulate under the oil immersion, globose-subglobose, often and somewhat angular, 7–14 μ diameter.

On *Andropogon Martini*: India. *Andropogon* sp.: Congo. *Chloris polydactyla*: Congo.

2. *Sorosporium pretoriaense* Zundel, n. sp.

Sori in the inflorescence 3–8 mm. long, broad at the base, covered with a delicate false membrane which flakes away revealing a brown granular spore mass surrounding a well developed columella.

Spore balls broadly ellipsoidal, opaque, dark reddish brown, containing many spores, temporary, usually 38–66 μ diameter, rarely 85 μ diameter.

Spores globose-subglobose, light olivaceous brown under the oil immersion, with a thick yellowish wall and a granular to vacuolated contents, smooth—5–7 μ diameter. .

On *Andropogon dichrous* (*Cymbopogon dichrous*), Pretoria, Union of South Africa, coll. I. B. Pole Evans, March 14, 1917 (U. D. Agr. Myc. Herb. 10045).

⁴ No material available for examination.

3. *Sorosporium* *Holstei* P. Henn. Pflanzenw. Ost-Afrikas Nachb. C: 49. 1895.

Sori in the inflorescence, long linear, 7 mm. long, covered by an evident false membrane which flakes away revealing a brown granular spore mass surrounding a well developed columella.

Spore balls subglobose-broadly ellipsoidal, opaque, with many spores, 50–114 μ diameter.

Spores globose-subglobose or rarely ellipsoidal, light reddish brown, under the oil immersion smooth, 5–8 μ diameter.

On *Andropogon hirtus*: Union of South Africa (Nyassaland). *Anthistiria Forskalii* (*Themeda Forskalii*; *T. triandra*): Tanganyika Territory; Union of South Africa (Transvaal).

4. *Sorosporium austro-africanum* Zundel, n. sp.

Sori in the inflorescence, long linear, 5–8 mm. long, solitary, covered by an evident yellowish false membrane which dehisces at the apex disclosing a mass of granular spores surrounding a well developed columella.

Spore balls semi-opaque, usually broadly ellipsoidal, usually 142–190 μ in diameter but sometimes as small as 47 μ , semi-permanent, containing a large number of spores, reddish brown.

Spores light reddish brown to almost hyaline, thick-walled; spores usually smooth except the outer spores, which are somewhat verruculose under the oil immersion, 5–10 μ diameter.

On *Andropogon cymbarius* (*Cymbopogon elegans*): Tugela River, Natal, Union of South Africa, coll. E. M. Doidge, May, 1920 (U. D. Agr. Myc. Herb. 14168).

This species differs from *S. pretoriaense* by having thicker-walled spores, which do not have a vacuolated contents and by having larger and more permanent spore balls.

5. *Sorosporium Healdii* Zundel,⁵ n. sp.

Sori in the inflorescence, usually concealed by the glumes, attacking the individual flowers and en masse producing a witches' broom-like growth, 2–3 cm. long and covered with a yellowish to brown colored false membrane which dehisces from the apex revealing numerous shreds.

Spore balls opaque, dark brown, globose-broadly ellipsoidal, somewhat irregular, permanent, 30 or more spores, usually 40–70 μ diameter but occasionally 90 μ diameter.

Spores globose-subglobose or very broadly ellipsoidal, ranging

⁵ Named for Frederick DeForest Heald, Ph.D., American Economic Ustilaginologist.

from reddish brown for the outer spores to almost hyaline for spores on the inner part of spore ball, thick-walled, sparsely verruculose under oil immersion, usually 6–10 μ diameter.

On *Andropogon cymbarius* (*Cymbopogon elegans*): Pretoria, Union of South Africa, coll. I. B. Pole Evans, May 7, 1916 (U. D. Agr. Myc. Herb. 9732).

This species is very closely related to *Sorosporium Clintonii* but differs in the shorter light colored sori, smaller and more regular spore balls and smaller spores. The spore balls are about the same size as in *Sorosporium contortum* but the spores are smaller in this new species. The spore balls of *S. Everhartii* are larger than in this species.

6. *Sorosporium EVERHARTII* Ellis & Gall. Jour. Myc. 6: 32. 1890.

Sori in the inflorescence, long linear, 1–2 cm. long, $\frac{1}{2}$ cm. wide, at first concealed by the glumes, covered with an evident false membrane which dehisces from the apex revealing a granular dark brown spore mass; spore balls globose-ellipsoidal, opaque, dark reddish brown, rather permanent, consisting of many spores, 40–125 μ diameter; spores globose-subglobose, somewhat irregular and angled, the spores on the outer part of the spore ball reddish brown, those on the inner part lighter (almost hyaline) in color, the free surface of the outer spores verruculose, otherwise smooth, under the oil immersion, 7–12 μ diameter.

On *Andropogon brachystachyus*: United States (Florida). *Andropogon diplandrus*: Congo. *Andropogon macourus*: United States (Florida). *Andropogon scoparius*: United States (Alabama, Connecticut). *Andropogon virginicus*: United States (Alabama, Georgia, Mississippi, New Jersey). *Gayana densiflora*: Congo. *Paspalum scobiculatum*: Congo.

7. *Sorosporium filiferum* (W. Busse) Zundel, n. comb.

Tolyposporium filiferum W. Busse, Arb. Biol. Abt. Landw.-Forstw. Kaiserl. Gesundheit 4: 383. 1904.

Sori destroying the ovaries, cylindrical elongated, 1–3 cm. long and 5–10 mm. wide, often curved at the end, covered with a thick membrane which ruptures from the tip downward revealing long dark brown threads and spore masses. Spore balls rather permanent, composed of many spores, 55–115 μ diameter, dark brown, opaque, subglobose-oblong; spores from inner part of

spore balls light yellowish brown, smooth, those from the outer portions of spore balls dark brown and papillate on the free side, globose-subglobose, 9–14 μ diameter.

Sori surrounded by an evident false membrane which breaks up into long linear cells.

On *Andropogon Sorghum*: Egypt; India; Kenya Protectorate; Union of South Africa; India; Mesopotamia.

8. *Sorosporium ELLISII* Winter, Bull. Torrey Club 10: 7. 1883.

Sori in the inflorescence, long linear, 1–2 cm. long, confined to the individual spikelets, covered with an evident membrane which shreds away revealing a dark brown granular spore mass, at first hidden by the sheath but later the end of the sori project from beneath the sheath; spore balls reddish brown, globose-subglobose, somewhat irregular, subopaque, with 30 or more spores, rather permanent, 40–100 μ diameter; spores light reddish brown, globose-ellipsoidal, angular, irregular, verruculose under oil immersion, 9–16 μ diameter.

On *Andropogon scoparius*: United States (Connecticut, Illinois, Kansas). *Andropogon virginicus*: United States (New Jersey). *Aristida dichotoma*: United States (Ohio, Pennsylvania).

9. *Sorosporium tumefaciens* (P. Henn.) Zundel, n. comb.

Ustilago tumefaciens P. Henn. Pflanzenw. Ost-Afrikas Nachb. C: 48. 1895.

Sori destroying the inflorescence, long linear, 1–1½ cm. long, concealed by the smaller floral sheaths, covered with an evident false membrane which flakes away revealing a black brown granular mass of spores; spore balls containing many spores, opaque, irregular, globose-ellipsoidal, rather permanent, dark brown, 55–85 μ diameter; spores reddish brown with the spores of the interior of the spore ball lighter color, irregular, globose-ellipsoidal, angular, generally smooth but outer spores echinulate on the free surface under oil immersion; 9–12 μ diameter.

On *Andropogon rufus*: French Congo. *Andropogon* sp.: Tanganyika Territory.

10. *Sorosporium ICOSIENSE* Maire, Bull. Soc. Hist. Nat. Afr. Nort. 7: 145. 1917.

Sori in the ovary, completely destroying the floral parts and covered with an evident membrane, which upon rupturing discloses a dark brown spore mass; spore balls containing 10–70

spores, dark reddish brown, globose-oblong or subglobose, 17–60 μ diameter; spores light reddish, globose-ellipsoidal, often somewhat angular, echinulate on the free surface under oil immersion, 9–12 μ diameter.

On *Andropogon distachyos*: Spain; Algeria.

11. *Sorosporium Ehrenbergii* Kuhn, Mitth. Ver. Erdkunde (Halle) 1877: 87. 1877.

Tolyposporium Ehrenbergii (Kuhn) Jacz. Russian Auct.

Sori destroying the ovaries, 15–20 mm. long, scattered singly throughout the panicle as hypertrophied ovaries which are covered with an evident false membrane which easily breaks up into globose-oblong, hyaline, sterile cells, 9–19 μ diameter; spore balls containing a large number of spores, globose-oblong, sometimes irregular, dense, reddish brown, fairly permanent but easily broken, usually 49–64 μ but sometimes 104 μ diameter; spores globose-subglobose; spores on interior part of ball tinted brown, those on outside light reddish brown, echinulate, 9–12 μ diameter.

On *Andropogon Sorghum*: Turkestan; Egypt.

12. *Sorosporium Tembuti* P. Henn. & Pole Evans, Bot. Jahrb. (Engler) 41: 270. 1908.

Sori in the ovaries and stamens, destroying them; in the ovary the sorus is covered with a false membrane which breaks up into sterile cells, revealing a granular mass of brown spore balls and a well developed columella; spore balls dark brown, opaque, with 60 or more spores, globose-oblong, usually 40–90 μ diameter; spores globose-subglobose, sometimes angled, echinulate on the free surface of outer spores of balls, otherwise smooth, medium to light reddish brown, the spores on the inner part of the spore ball being lighter colored than those near the outer part, 9–11 μ diameter, rarely 14 μ .

On *Andropogon cymbosus*: Union of South Africa. *Andropogon excavatus* (*Cymbopogon excavatus*): Union of South Africa. *Andropogon validus* (*Cymbopogon validus*): Union of South Africa. *Andropogon* sp.: Congo.

13. *Sorosporium proliferatum* Zundel, n. sp.

Sori causing ~~the~~ proliferations in the inflorescence resembling miniature ears of corn, concealed by numerous large outer glumes, 2–8 cm. long, covered by an evident false membrane which flakes away revealing a dark brown mass of granular spore balls and a large number of long dark shreds.

Spore balls globose, ellipsoidal, sometimes angled, opaque, with many spores, permanent, usually 45–60 μ diameter, sometimes up to 85 μ diameter.

The spores in the outer part of the spore ball dense, dark reddish brown, while the inner spores are nearly hyaline, somewhat irregular in size and shape, ranging from globose-subglobose, occasionally angled. Mostly 9–22 μ diameter, abundantly verruculose under oil immersion.

On *Andropogon hirtus*: Waterval Boven, Union of South Africa, coll. I. B. Pole Evans, November 29, 1918 (U. D. Agr. Myc. Herb. 11336).

This smut is very distinctive in the formation of proliferated sori very similar to those produced by *Sorosporium Reilianum* on *Zea Mays* but differs in the permanent and smaller spore balls. It may be the parent of *Sorosporium Reilianum*.

14. *SOROSPORIUM REILIANUM* (Kühn) McAlp. Smuts of Austral.
181. 1910.

Sphacelotheca Reiliana (Kühn) Clinton, Jour. Myc. 8: 141.
1902.

Sori occurring in either ♀ or ♂ inflorescence, usually causing complete destruction, covered with an evident membrane of host tissue which ruptures disclosing a brown spore mass and numerous columella; the sori are frequently covered by proliferations of the tassel or ear; spore balls irregular in shape, generally opaque, dark reddish brown, easily disintegrating at full maturity of spores; spore balls found only in young specimens, 76–150 μ diameter; spores reddish brown, globose-subglobose, occasionally somewhat angled, thick-walled, abundantly echinulate under oil immersion, 9–14 μ diameter.

On *Andropogon arundinaceus*: Tanganyika Territory; Toso. *Andropogon halepensis*: Italy; Sudan; Union of South Africa; India; Caucasia (Georgia). *Andropogon Sorghum*: United States (California, Nebraska, New Jersey, New Mexico, Ohio, Texas, Utah, Washington); Bulgaria; Czechoslovakia; Germany; Italy; Russia; Spain; Yugoslavia (Serbia); Egypt; Tanganyika Territory (Usambara); Caucasia (Georgia); India; Japan; Turkestan; *Andropogon* sp. (*Sorghum* sp.): Hawaii; Philippine Islands. *Sorghum caudatum*: Kenya Protectorate. *Zea Mays*: United States (California, Kansas, Ohio, Washington); Azores Islands; Czechoslovakia; Germany; Hungary; Portugal; Russia; Egypt. Kenya Protectorate; Union of South Africa; Australia.

15. *Sorosporium provinciale* (Ellis & Gall.) Clinton, Jour. Myc. 8: 145. 1902.

Sorosporium Ellisii provinciale Ellis & Gall. Jour. Myc. 6: 31. 1890.

Sori in the inflorescence, long linear, 6–8 cm. long, entirely hidden by the sheath or sometimes the end partially protruding, covered by a false membrane which flakes away revealing a dark brown powdery spore mass; spore balls globose, somewhat irregular, containing more than 30–40 spores, reddish–dark reddish brown, sometimes opaque, fairly permanent, 45–105 μ in diameter; spores reddish brown, globose-subglobose, evenly thick-walled, 3–4 μ , verruculose under the oil immersion, 11–20 μ diameter.

On *Andropogon provincialis* (*A. furcatus*): United States (Missouri, Nebraska).

16. *Sorosporium geminellum* H. & P. Sydow & Butler, Ann. Myc. 10: 253. 1912.

Sori completely destroying the inflorescence, solitary, long linear, 2–7 mm. long, at first hidden by the sheath, covered by an evident false membrane which upon rupturing reveals a dark brown granular mass of spores surrounding a well formed columella; spore balls opaque, deep reddish brown, globose-subglobose, consisting of more than 15 spores, semi-permanent, usually breaking down soon after maturity, usually 35–50 μ diameter but occasionally 60 μ diameter; spores reddish brown, sometimes globose, usually angular, polygonal or triangular, apparently smooth but indistinctly verruculose under the oil immersion, 12–17 μ diameter.

On *Andropogon* sp.: India.

17. *Sorosporium Hodsonii* Zundel,^{*} n. sp.

Sori in the inflorescence, solitary, large, 3–5 cm. long, at first hidden by the outer sheath, covered by an evident membrane which flakes away revealing a brownish granular spore mass intermixed among the shreds.

Spore balls globose-ellipsoidal, reddish brown, semi-opaque, semi-permanent, variable in size, ranging from 50–115 μ diameter, with many spores.

Spores globose-subglobose, often somewhat angled, light reddish brown, thick-walled, vacuolated contents, abundantly echinulate under oil immersion, 8–10 μ diameter.

^{*} Named for Dr. John W. Hodson, American Mycologist.

On *Andropogon* sp.: Hopefield (Lawley post office), Union of South Africa, coll. not known, February 2, 1910 (U. D. Agr. Myc. Herb. 704).

18. *Sorosporium filiformis* (P. Henn.) Zundel, n. comb.

Ustilago filiformis P. Henn. Bot. Jahrb. (Engler) 34: 254. 1901.

Sori destroying the inflorescence and forming into long tubular structures 4–8 cm. long, stuffed with spores. The tubular structure consists of a covering of false tissue which breaks up into long shreds or rows of cells. Spore balls consisting of many spores, globose-ellipsoidal, opaque, dark brown, rather permanent and surrounded by a distinct halo, 60–125 μ diameter; spores deep reddish brown, globose-subglobose; spores on inner parts of spore ball more or less hyaline, thick-walled, verruculose (especially the free surfaces of the outer spores) under oil immersion, 9–12 μ diameter.

On *Andropogon contortus* (*Heteropogon contortus*): Africa.

19. *Sorosporium Clintonii* Zundel,[†] n. sp.

Sori in the inflorescence, large, 2–6 cm. long and often 5 mm. wide, at first concealed by the glumes, covered with a dark brown false membrane. Sori attacking individual flowers and en masse producing a witches' broom-like growth; shreds appear as false membrane flakes away.

Spore balls irregular, globose-oblong and often angled so that they are often more or less rectangular, dark reddish brown, opaque, permanent, mostly 66–114 μ but ranging from 47–133 μ diameter, containing many spores.

Spores on the outer portion of the spore ball dark reddish brown while those on the interior are only tinted brown; thick cell wall about 1.5 μ thick, irregular in shape but mostly globose-subglobose, frequently angled, verruculose under oil immersion; spores 8–17 μ .

On *Andropogon cymbarius* (*Cymbopogon elegans*): Waterhloof, Pretoria, Union of South Africa, coll. I. B. Pole Evans, April 14, 1916 (U. D. Agr. Myc. Herb. 9693).

This species is closely related to *Sorosporium contortum* but differs in the more irregular, larger, angular spore balls, in the production of witches' broom-like sori and in the dark brown false membrane covering the sori.

[†] Named for Dr. George Perkins Clinton, American authority on Ustilaginales.

20. *SOROSPORIUM CONTORTUM* Griff. Bull. Torrey Club **35**: 148. 1908.

Sori in the ovaries, long linear, 3–5 cm. long, completely destroying inflorescence, at first hidden by the sheath, covered with a thick light colored false membrane which flakes away disclosing a brown granular spore mass; spore balls dark brown, opaque, globose-oblong, 47–91 μ diameter; sterile tissue firmly bound together; sterile cells long angular, often 2–3 times as long as broad, sometimes cubical, thick-walled; spores dark reddish brown on outer portion of spore ball while those on the interior are scarcely colored, globose-subglobose, 9–13 μ diameter; outer spores verruculose, otherwise smooth.

On *Andropogon contortus* (*Heteropogon contortus*): United States (Arizona, New Mexico).

21. *SOROSPORIUM MARANGUENSE* P. Henn. Pflanzenw. Ost-Afrikas Nachb. **C**: 49. 1895.

Sori in the inflorescence at first covered by the leaf sheaths; finally tips of sori protrude beyond the sheath, covered by an evident membrane, long linear, shredded, 3–6 cm. long.

Spore balls subglobose, angular, many-spored, 35–65 μ , semi-permanent.

Spores angular, subglobose, irregular, under oil immersion granular contents, verruculose (at least the outer spores), light reddish brown (almost a yellow), the thick spore wall darker reddish brown, 10–14 μ diameter.

On *Andropogon lepidus* (*A. cymbarius*): Tanganyika Territory.

22. *SOROSPORIUM HETEROPOGONIS-CONTORTI* Baccarini, Ann. Bot. (Italy) **14**: 132. 1917.

Sori infecting the inflorescence, oblong-linear, included in a smooth grayish yellow sheath; spore balls globose, many-spored, 40–45 to 40–70 μ , dark; spores globose, olive brown, smooth, internally pitted, 9.6–11.2 μ diameter.

On *Andropogon contortus*: Abyssinia.

23. *Sorosporium harrismithense* Zundel, n. sp. .

Sori in the inflorescence, long, large, 3–4 cm. long, 5–6 mm. wide, solitary, surrounded by a brown false membrane which flakes away from the apex revealing a shredded mass of plant tissue and a brown granular mass of spores.

Spore balls globose-subglobose, opaque, semi-permanent, dark reddish brown, 47–105 μ diameter.

Spores globose to broadly ellipsoidal, angular, reddish brown, with thick cell wall, echinulate under oil immersion, 10–14 μ diameter.

On *Andropogon* sp.: Harrismith, Union of South Africa, coll. C. P. v. d. Merwe, February 22, 1911 (U. D. Agr. Myc. Herb. 1473).

24. *Sorosporium Simii* P. Henn. & Pole Evans, So. Afr. Jour. Sci. 12: 543. 1916.

Sori destroying the inflorescence, long linear, 5–7 cm. long, 1–2 cm. wide, dark brown and covered with a false membrane which flakes away disclosing long brown shreds in which the spores are produced; spore balls globose-subglobose, opaque, containing many spores and easily disintegrating; sterile tissue rather permanent, breaking up chiefly into groups or sometimes chains of cells, rarely as individual cells, tinted brown to dark brown; sterile cells about the size of the spores; distinctive globose groups of 4–6 spores scattered throughout the sori, 19–36 μ diameter; spores olivaceous to reddish brown, globose-subglobose, abundantly but finely echinulate under oil immersion and granular, 9–13 μ diameter.

On *Andropogon halepensis*: Union of South Africa (Natal).

25. *Sorosporium Caledonicum* Pat. Bull. Soc. Myc. (France) 3: 173. 1887.

Sori at first concealed by the sheath, 3–5 cm. long, shredded, with the ends of the shreds finally protruding.

Spore balls rather firm, not easily disintegrated, irregular, globose to ellipsoidal, often angular, containing 30–90 or more spores, 30–104 μ in diameter, reddish brown.

Spores globose-subglobose, regular, minutely echinulate under the oil immersion lens, reddish brown, 9–12 μ in diameter.

26. *Sorosporium Flanaganianum* Zundel, n. sp.

Sori in the inflorescence, broad, long linear, 2–4 cm. long, solitary, surrounded by a thick brown false membrane which flakes away revealing fine shreds and a brown granular spore mass.

Spore balls globose-subglobose, opaque, with many spores, dark reddish brown, semi-permanent, usually 75–95 μ , as small as 47 μ .

Spores subglobose, irregular, angled, reddish brown, abundantly echinulate under oil immersion, usually 10–14 μ diameter.

On *Andropogon* sp.: Emmasdale, Heidelberg, Union of South Africa, coll. not known, January 15, 1910 (U. D. Agr. Myc. Herb. 713). *Andropogon* sp.: Prospect Cape, Union of South Africa, coll. H. Flanagan, January 1, 1916 (U. D. Agr. Myc. Herb. 9423).

27. SOROSPORIUM DENBIANENSE Baccarini, Ann. Bot. (Italy) 14: 132. 1917.

Sori destroying the ovaries and stamens, dark, included in a yellowish sheath, 5–7 mm. long; spore balls irregular, globose-ellipsoidal, 27–40 to 35–50 μ diameter, composed of 10–18 spores; spores globose-angular to ellipsoidal, easily separated, 9.6–11.2 μ , minutely spiny.

On *Andropogon arrhenobasis* (*Heteropogon arrhenobasis*): Abyssinia. *Andropogon papillipes*: Abyssinia.

28. SOROSPORIUM ANDROPOGONIS-ACICULATI Petch, Ann. Roy. Bot. Gard. Peradeniya (Ceylon) 5: 227. 1912.

Sori destroying the inflorescence, long linear, 4–7 cm. long, at first hidden by the sheath, later at least the greater part protruding, covered with an evident brown false membrane which flakes away revealing a brown, granular spore mass and long shreds of tissue; spore balls dark brown, opaque, permanent, globose-oblong, containing many spores, ranging from 28–76 μ diameter but usually 40–75 μ ; spores globose-subglobose, sometimes irregular, very light brown, smooth, 4–6 μ diameter.

On *Andropogon aciculatus* (*Chrysopogon aciculatus*): Ceylon; Japan; Philippine Islands.

TOLYPOSPORELLA Atk. Bull. Cornell Univ. 3¹: 16. 1897

Spores less than 19 μ in diameter.

Spores regular; epispore with concentric ring-like markings. *T. Brunkii*

Spores irregular; smooth epispore. *T. irregularis*

Spores 20 μ or more in diameter.

Spores regular, 13–29 μ , smooth. *T. obesa*

1. TOLYPOSPORELLA BRUNKII (Ellis & Gall.) Clinton, Jour. Myc. 8: 147. 1902.

Ustilago Brunkii Ellis & Gall. Jour. Myc. 6: 31. 14 My. 1890.

Sori on the under side of the leaf sheath as striae which fuse forming a thick coating of granular spores; sori frequently

showing through on the upper side of the leaf sheath; spore balls not definite; spores more or less agglutinated; spores smooth with a central faintly granular endospore and an episporium with concentric ring-like markings; spores ranging from light reddish brown when young to dark reddish brown for the older spores, chiefly 9–19 μ diameter; episporium chiefly 2–4 μ thick.

On *Andropogon argenteus*: United States (Texas). *Andropogon hirtiflorus*: Mexico. *Andropogon saccharoides*: United States (Texas); Mexico.

2. *Tolyposporella irregularis* (Pazsche) Zundel, n. comb.

Tilletia? irregularis Pazs. Hedwigia 34: 101. 1895.

Sori on the under surface of the leaf sheath, sometimes showing through and occasionally breaking through on the upper surface, forming short striae which frequently merge forming a mass of black granular spores; spore balls irregular in size, 25–175 μ , with loosely connected spores (more or less agglutinated); spores smooth, irregular in shape, varying from globose to subglobose, often more or less angular, olive brown, 9–16 μ diameter and with an episporium about 2 μ thick; spore color varying with age, immature spores light olive brown, mature spores dark olive brown.

On *Andropogon* sp.: Brazil.

3. *Tolyposporella obesa* (H. & P. Sydow) Clinton & Zundel, n. comb.

Entyloma obesum H. & P. Sydow, Ann. Myc. 9: 145. 1911.

Sori occurring on the leaves, tar-spot-like, up to 4 mm. diameter, raised; spores en masse dark reddish brown, singly, light reddish brown to light olive or occasionally nearly hyaline, subglobose-ellipsoidal, very irregular and angular by compression, with an endospore surrounded by a swollen episporium with rather distinct concentric striations; spores 13–29 μ diameter; endospore 5–10 μ diameter; spore balls very indefinite but spores adhere rather firmly; contents of endospore granular; spores smooth.

On *Andropogon annulatus*: India.

The structure of the spores and the superficial position of the sori on the surface of the host plant exclude this fungus from the genus *Entyloma*. It cannot be placed in *Sirentyloma* due to the lack of long chains of spores extending into the host tissues.

Note. After this article had gone to press the description of the following new smut came to the attention of the author.

Ustilago Taiana H. Sydow, Ann. Myc. 27: 421. 1929. On *Andropogon micranthus* Kunth., prov. Kiangsu, Nanking, China. Leg. Dr. F. L. Tai (no. 2190).

PENNSYLVANIA STATE COLLEGE,
STATE COLLEGE, PA.

NOTES AND BRIEF ARTICLES

It may be of interest to students of the Peronosporaceae to know that *Peronospora Valerianellae* Fuckel was found on *Valerianella radiata* in two localities in northwestern Arkansas in April, 1929. There appears to be no record of the occurrence of this mildew in North America but it does not seem probable that it is confined to the Ozarks.—J. J. DAVIS.

Dr. G. W. Martin of the University of Iowa spent the month of March at The New York Botanical Garden working over the slime-mould collection. Dr. Martin is collaborating with Professor T. H. Macbride on a revision of his slime-mould book and is planning later to monograph the group for North American Flora.

Dr. Mary J. S. Whetstone, Corresponding Secretary of the Minnesota Mycological Society, died of pneumonia at her home in Minneapolis, October 24, 1929, at the age of 80 years. As Mary J. Snoddy, she received the degree of M.D. from the University of Michigan in 1881. She was a practicing physician but had been interested for many years in the study of fungi. Her husband, Allen S. Whetstone, who was also a physician (Univ. of Mich., M.D. 1880), died at Minneapolis more than twenty years ago (April 19, 1909).

THE PENICILLIA

This voluminous work by Dr. Charles Thom, Principal Mycologist, Bureau of Chemistry and Soils, U. S. Department of Agriculture, assisted by Margaret B. Church, O. E. May, and M. A. Raines, has just been issued. The genus *Penicillium*, so called by scientists because of the resemblance of the fruiting bodies to miniature brushes but better known to the layman in general and especially to the house-wife as blue-green mould, is one of the most common and widely distributed genera of the fungi. It is, at the same time, one of the most difficult groups

to deal with because of the numerous species which have been described and in many cases very poorly characterized. Dr. Thom has undertaken in this work to bring together and summarize our knowledge of the known species.

After characterizing the genus in the introductory chapters considerable space is devoted to the "Distribution and Significance in Nature and Industry" of the various species of the genus. No group of fungi is of more interest from an economic point of view. In the rotting of bulbs; in the destruction of stored foods; in the decay of fibers; and in the deterioration of leather, meat, nuts, sugar, tobacco, etc., they are one of the most active agents and are truly the weeds of the fungus world. The annual loss from their attacks is difficult to estimate.

Not even man himself is free from the attacks of these lowly organisms. They are found associated with and may be the cause of diseases of the ear, eye, nails, skin, and even the lungs and other vital organs. They are also associated with diseases of other higher animals. After a thorough discussion of the general characters and economic importance of *Penicillia* the major portion of the book is devoted to a detailed treatment of the recognized species. The volume consists of i-vii + 1-644 pages and contains 99 illustrations. Published by The Williams & Wilkins Company, Baltimore, Maryland. Price \$10.00.

FRED J. SEAVER

FUNGI DAKOTENSES

Dr. J. F. Brenckle's "Fungi Dakotenses," Fascicle 27, was issued October, 1929, and contains the following species: 651. *Aecidium Anograe*; 652. *Bullaria tumidipes*; 653. *Camarosporium umbonatum* n. sp.; 654. *Teichospora umbonata*; 655. *Cercospora dubia*; 655a. *Cercospora dubia*; 656. *Coleosporium Solidaginis*; 657. *Cytospora Amorphae*; 658. *Dicaeoma Asterum* I. 2a. *Dicaeoma Fraxini* I.; 659. *Dicaeoma Jamesianum* I.; 660. *Dicaeoma Rhamni* I.; 661. *Entyloma compositarum* [should be *E. polysporum*]; 478a. *Eutypella oviculata*; 662. *Fenestella princeps*; 663. *Labriella Cornu-cervi* n. sp. & n. gen.; 664. *Lachnum sulphureum*; 665. *Patellaria atrata*; 666. *Parodiella grammodes*; 667. *Phialea sordida*; 668. *Phragmidium americanum*; 669. *Pleospora pygmaea*;

670. *Sordaria amphisphaerioides*; 671. *Sphacelotheca Ishaemi*; 672. *Stagonospora Meliloti*; 673. *Urocystis occulta*; 674. *Ustilago Avena*; 675. *Ustilago hypodytes*; 90a. *Ustilago levis*. On the back of table of contents of this fascicle the following new species and genera are described: **Labridella** n. gen. Leptostromataceae. Pycnidia dark, linear to lanceolate, separate or several aggregate, rimose-gaping, ramicole. Conidia unequally septate, dark, with a branched hyaline appendix and a rod-like basidium. **Labridella Cornu-cervi** n. sp. Pycnidia black, linear when young, lanceolate and rimose-gaping as spores develop, .5 to 2 mm. long by .2 to .5 mm. wide. Pycnidial membrane black, granular, two-layered: an outer composed of dark, septate, branched hyphae, closely packed; an inner hyaline-yellow with indistinct cells. Dehiscent by cracking and spreading of the dome, the edges of the membrane falling away and finally widely open. Conidia dark brown, lanceolate, straight or slightly curved, sharply narrowed at the base to a hyaline basidium, tapering at the upper end to a long branched, hyaline appendix with two to five branches springing from one side, mostly near the base, often curved and spread much like a deer-horn. Mature conidia are unequally four-septate, the proximal cell is cone-shaped and joins with the basidium, the second cell is much the largest and usually retains its nucleus, the three remaining cells are about equal in length, but narrowed somewhat toward the end. The basidium is about 8 to 12 by 2 mic. in size. The body is about 30 to 35 by 8 to 11 mic. and the appendix about as long, and 3 to 4 mic. wide at the base. On bleached wood or erumpent through falling bark of *Symphoricarpos occidentalis*. **Camarosporium umbonatum** n. sp. Perithecia separate, scattered or aggregated about the nodes and small twigs, erumpent but soon superficial by falling of the bark, conical to hemispherical, chestnut-brown to black, smooth and shiny, .2 to .4 mm. wide. Conidia lanceolate, brown, 3-septate, one of the mid cells longitudinally divided, 14 to 17 by 6 to 7 mic. in size. Probably related to *Teichospora umbonata* E. & E. On dead twigs and stems of *Symphoricarpos occidentalis*.



ELVELA CALIFORNICA

MYCOLOGIA

VOL. XXII JULY-AUGUST, 1930

No. 4

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XII ELVELACEAE¹

FRED J. SEAVER

(WITH PLATES 17-19)

Since the publication of "The North American Cup-fungi (Operculates)" a number of interesting illustrations have come to hand which were not available for that work. It is the purpose of the writer to publish such illustrations from time to time to supplement the work cited above. Since many of the cup-fungi do not occur in the vicinity of New York City it is difficult to get photographs from fresh material and in such cases it is necessary for the writer to depend upon contributors for illustrations from life specimens. He will greatly appreciate any contribution of this nature which can be furnished, especially when accompanied by dried specimens for confirmation. When these are reproduced full acknowledgment will be given.

ELVELA CALIFORNICA

This species was described by Phillips in 1880 from material collected in California, and was illustrated (Trans. Linn. Soc. II. 1: *pl.* 48) by an excellent drawing. So far as has been observed this species has never before been illustrated from original photographs. The writer has recently received from Miss Maude E. Morris of Seattle, Washington, some excellent photo-

¹ This paper is supplementary to The North American Cup-fungi (Operculates) which was published by the author and issued December, 1928.

[MYCOLOGIA for May-June (22: 103-161) was issued May 1, 1930]

graphs and specimens of this species, the photographs having been made by Mr. C. F. Todd of Seattle, Washington.

This species is very closely related to the writer's species *Elvela umbraculiformis*, (N. Am. Cup-fungi 250, pl. 41), our species being characterized by the very much shortened stem so that the pileus appears almost sessile. The length of the stem is not usually a very good specific character and it is possible that further investigation will show our species to be merely a form of the one described by Phillips. We do not have sufficient data at the present time to confirm this view. The largest specimen collected by Miss Morris was reported to be eight inches across. The stem is deeply convoluted, the convolutions forming ridges underneath the pileus. We are greatly indebted to Miss Morris for her contribution of specimens and photographs of this western species.

MORCHELLA CRASSIPES

During the spring of 1929, an unusually large and interesting specimen of the above species was brought to the writer, having been collected by Herman Johnson at Pelham, New York. This specimen was ten inches in height and as indicated by the specific name the base was strongly inflated. While the species is commonly known as "the thick-footed morel" this character is not always evident as it is in this particular specimen, which was photographed by Miss Fleda Griffith of The New York Botanical Garden. In studying this specimen it is noted that although the asci are normally 8-spored occasionally one is found which contains but four spores and these unusually large. The ascus in such cases was found in tact and there were no trace of aborted spores. It is probably that such spores are double nucleated as has been suggested by B. O. Dodge in connection with his studies on the Ascomycetes.

THE NEW YORK BOTANICAL GARDEN

EXPLANATION OF PLATES *

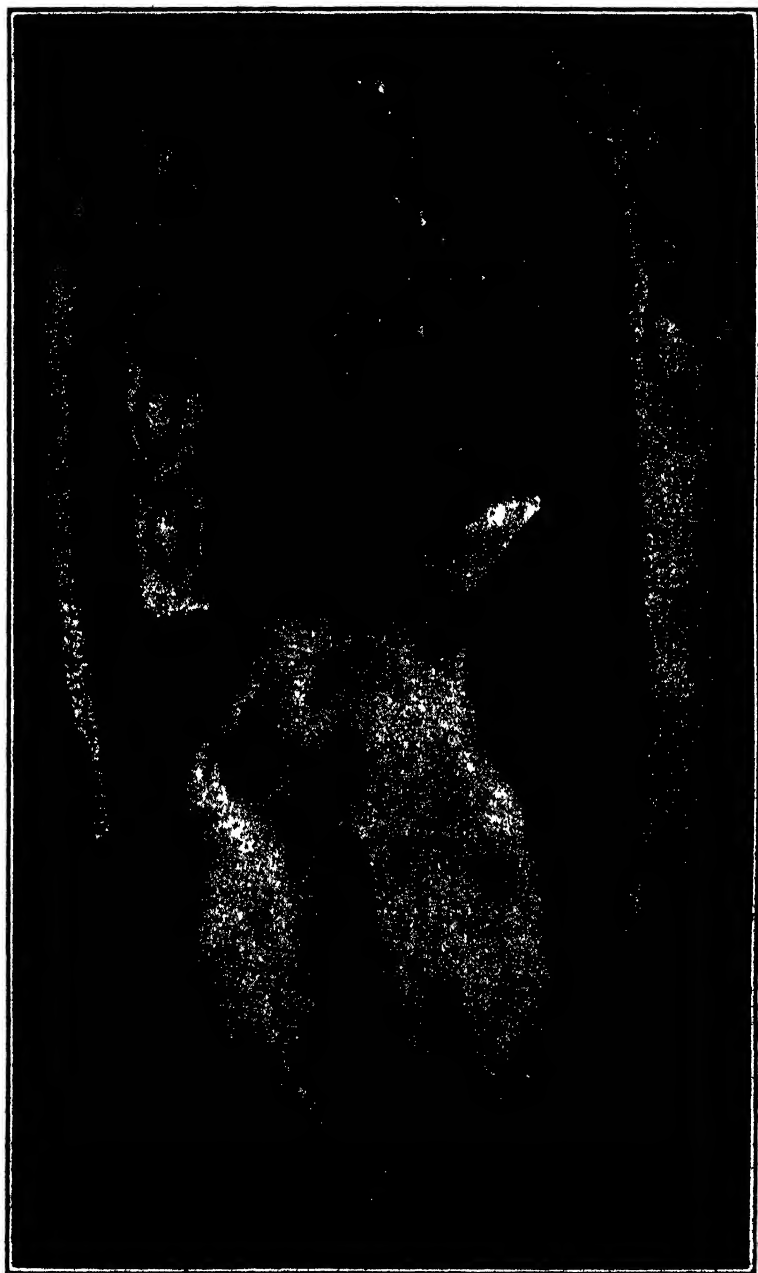
Plate 17. *Elvela americana* about one-third natural size, with drawings of an ascus with spores and a paraphysis, also diagram of section of stem.

Plate 18. *Elvela americana* about two-thirds natural size. The specimen measured eight inches across.

Plate 19. *Morchella crassipes*, about two-thirds natural size, the specimen measuring ten inches in height; also drawings of asci with spores and a paraphysis.



ELVELA CALIFORNICA



MORCHELLA CRASSIPES

A NEW SPECIES OF CHAETOMELLA ON ROSE

MARJORIE E. SWIFT

(WITH 1 TEXT FIGURE)

Small dark bean-shaped pycnidia were observed growing on a rose twig brought into the pathology laboratory of The New York Botanical Garden in September, 1929. The fungus was cultured and its development followed. Its characters brought it within the genus *Chaetomella* as described by Fuckel (Symb. Myc., p. 401. 1869) as follows:

Perithecia superficialia, brevissime pedicellata, astoma, ubique sparse setosa. Asci nulli. Stylosporae in sporophorum ramosorum apicibus, simplices, cylindraceae, vel subfusiformes, subcurvatae, quandoque coloratae.

Chaetomella raphigera sp. nov.

Pycnidia dark brown, $126-238 \times 98-176 \mu$ (average $178.4 \times 132 \mu$), reniform, with a single ridge or raphe extending lengthwise over the top, scantily setose, astomous, typically superficial and solitary, attached to substratum by a short hyaline stalk; pseudo-parenchymatous wall formed of three tissues of parallel-lying hyphae, the outer consisting of one or two layers of thin-walled light-colored cells, the central of two or three layers of dark brown carbonous cells, and the inner of four or five layers of light-colored thin-walled cells. From the latter tissue grow long slender hyaline hyphae, filling the cavity of the young fruit body with sterile hairs extending upwardly towards the dorsal ridge.

Setae $17.5-77.5 \times 2-5.4 \mu$, tips $5-7.5 \mu$ (average $51.5 \times 2.8 \mu$, tips 5.7μ), clavate, with straight, bent or hooked tips, 20 to 50 in number and distributed more or less evenly on either side of the raphe, 1-4 septate, dark brown and thick-walled except the tip cell which is thin-walled and light in color; basal cell modified to form a foot somewhat swollen at or near the point of union with the pycnidium wall.

Spores hyaline, frequently pale olivaceous in mass, $4-8.1 \times 1.4-3 \mu$ (average $5.46 \times 2.1 \mu$), one-celled, cylindrical to slightly

fusiform, often somewhat allantoid, containing 1 to 3 refractive bodies, borne on slender more or less verticillately branched sporophores arising from a flattened cushion at the base of the pycnidium.

Mycelium mainly submerged, hyaline, branching, septate, 1.5–5 μ , with homogeneous or oily contents; aërial hyphae low-growing, white, aggregating in loose ropes.

On *Rosa* and *Rubus*.

Type specimen collected on *Rosa* sp. in New York in 1929.

DISTRIBUTION: New York and Virginia.

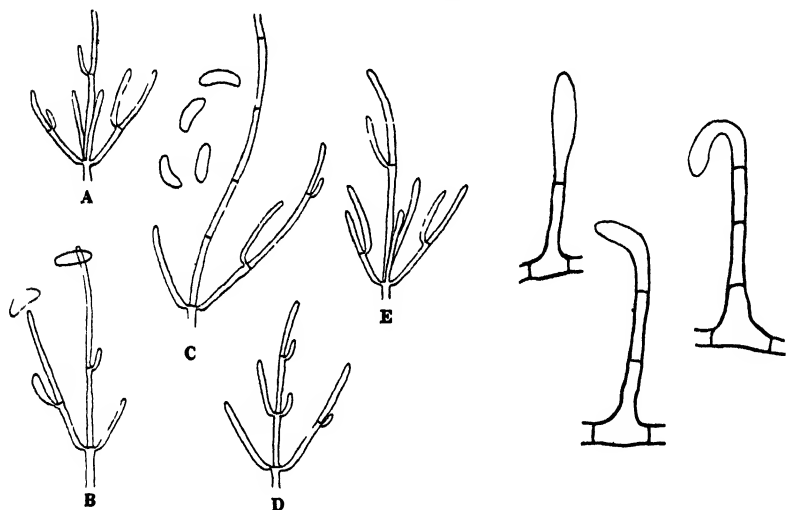


FIG. 1. A-E, sporophores and spores, $\times 1000$. (C, possibly a sterile hypha.) F, types of setae on pycnidium, $\times 600$.

Colonies on corn meal agar are usually concentrically zoned, the mycelial growth well in advance of the fruit bodies which appear to the naked eye as small dark brown or black dots distributed evenly in the center of the culture, or following roughly the concentric zones of the mycelium. Mycelial growth, as well as pycnidial formation, is much more abundant on dextrose and potato dextrose than on corn meal media.

The pycnidia have been observed to be typically solitary, but they may occur in small groups of three or four attached to the substratum by the same stalk. As noted, a single low ridge or raphe along the top divides the pycnidium more or less symmetrically. However, a number of three-sided fruit bodies have

been seen, with a ridge separating the three surfaces, giving the pycnidium a somewhat trihedral appearance from above.

Spore release might be expected to occur through a splitting of the pycnidium along the suture. When a cover glass is tapped gently the fruit body under it breaks in an even line along the ridge, but when a slightly greater pressure is applied an irregular break occurs. No natural splitting has been observed even in old cultures, but dry fruit bodies often appear to be sunken along one side of the ridge, transforming the pycnidium into an inequilateral or concave-convex body.

Table I lists the described species of *Chaetomella* with their spore measurements or other distinguishing features, and the recorded substrata.

TABLE I. SPECIES OF CHAETOMELLA

Species	Spore Measurements, etc.	Substratum
<i>C. Andropogonis</i> Cooke & Ellis	6×5μ; setae rigid, 250μ	<i>Andropogon</i>
<i>C. Artemisiae</i> Cooke	8-10×4μ	<i>Artemisia</i>
<i>C. atra</i> Fuckel	12-15×2-3μ	<i>Phragmites</i> , <i>Carex</i> , <i>Arundo</i> and maize
<i>C. atra</i> var. <i>bambusina</i> Sacc. & Scalia	13-15×2-3μ	<i>Bambusa</i>
<i>C. atra</i> var. <i>charticola</i> F. Tassi	14-16×2.5-3μ	Old paper
<i>C. atra</i> var. <i>lignicola</i> Sacc.	12-15×2.5μ	Bark
<i>C. beticola</i> Oud.	10-12×6-7μ	<i>Beta</i>
<i>C. brachyspora</i> Sacc. & Speg.	5-6×3μ, dark; pycnidia depressed	<i>Catalpa</i>
<i>C. Brassicae</i> (Schw.) Starb. (<i>Sphaeria Brassicae</i> Schw.)	5-10 μ	<i>Brassica</i>
<i>C. eucrypta</i> Cooke & Mass.	16×10μ	<i>Knightia</i>
<i>C. furcata</i> Cooke & Mass.	10-11×8μ	Coriaceous leaves
<i>C. horrida</i> Oud.	5.5-7×3.5-4μ; setae branched	<i>Betula</i>
<i>C. longiseta</i> Delacr.	6×4μ; setae rigid, pointed	<i>Pisum</i>
<i>C. Melandryi</i> G. Frag. (<i>Amerosporium Melandryi</i> (G. Frag.) P. & S.)	9-13×3-2.5μ	
<i>C. oblonga</i> Fuckel	11×2μ	<i>Rosa</i>
<i>C. oblonga</i> var. <i>major</i>	11×2μ; pycnidia large	<i>Quercus</i>
<i>C. perforata</i> Ellis & Ev. (<i>Acanthostigma occidentale</i> (Ellis & Ev.) Sacc.) (<i>Venturia occidentalis</i> Ellis & Ev.)	20-25×4-5	<i>Cirsium</i>
<i>C. raphigera</i> Swift	5.5×2μ	<i>Rosa</i>
<i>C. raripila</i> (Mont.) Sacc. (<i>Chaetomium raripilum</i> Mont.)	13-14×2μ	<i>Polygonum</i>
<i>C. Sacchari</i> Delacr.	10-18×9μ	<i>Saccharum</i>
<i>C. Stevensoni</i> Ellis	19-26×2.5-3μ	<i>Desmodium</i>
<i>C. tortilis</i> Delacr.	12.5×6.5μ	<i>Populus</i>

Chaetomella oblonga collected on *Rosa rubiginosa* by Fuckel in Austria (Symb. Myc. p. 401, 1869) is the only one of these which resembles the above-described fungus in any material respects, but several important differences distinguish the two forms.

First, the spore measurements of *C. oblonga* are $11 \times 2 \mu$. Those of the present fungus are $4-8.1 \times 1.4-3 \mu$ (average $5.46 \times 2.1 \mu$).

Examination of No. 1962 of *C. oblonga* in Fungi Rhenani in the Harvard University Herbarium, was very kindly made by Dr. W. H. Weston through the courtesy of Professor Thaxter. The fifty spores measured ranged from 7 to 11.3μ in length by 1.5 to 2μ in width. Although the length of these spores is slightly less than that recorded by Fuckel, there is still no question that the dimensions are distinctly different from those of our species found on rose in New York.

Second, the setae of *C. oblonga* are described as rigid and evenly colored. Curved and hooked hairs, although not numerous on the pycnidia of the fungus described in this paper, are sufficiently noticeable to attract attention. The swollen light-colored tips could not escape mention (FIG. 1, F).

Third, the most striking feature of the pycnidium upon superficial examination is the ridge or raphe along the top. This was apparently not present in *C. oblonga*.

In view of these differences, the fungus described herein is believed to be a new species, and is given the name *Chaetomella raphigera*, because of the ridge-like marking extending over the dome of the pycnidium.

A *Chaetomella* was found on rose and blackberry by Dr. C. L. Shear and Dr. B. O. Dodge at Rosslyn, Virginia, on several occasions from 1920 to 1926. Sections of the material made at that time were loaned the writer for examination, and measurements indicate the identity of the New York form and that found in Virginia. Certain features of *C. raphigera* are described in greater detail elsewhere in this journal by Dr. Dodge, to whom acknowledgment is made for material suggestions in the preparation of this paper.

THE NEW YORK BOTANICAL GARDEN

DEVELOPMENT OF THE ASEXUAL FRUCTIFICATIONS OF CHAETOMELLA RAPHIGERA AND PEZIZELLA LYTHRI

B. O. DODGE

(WITH PLATES 20 AND 21)

Mycologists now seldom use the term pleomorphic in referring to a fungus which has different spore forms in its life cycle. Medical mycologists however still use the term in a rather restricted sense. When *Trichophyton gypseum*, for example, changes its habit of growth in culture to produce a whitish, fluffy cottony, more or less sterile mycelium they say the culture has gone pleomorphic. On Sabouraud's conservation medium their fungus is more apt to remain stable and so is kept in its original form for study. Once it has "become pleomorphic" on any medium it is said not to revert to its original type when transfers are made. Such behavior as this mycologists would perhaps call mutations or saltations. Recent mycological literature is full of examples of races of fungi which are unstable and inclined to "mutate" especially when grown on certain media. Prospects for further important contributions on this subject are encouraging for the reason that plant pathologists as well as mycologists are giving their attention more and more to biologic or physiologic races, their origin and nature. It is being realized that the question regarding the stability of a race,—whether the variations or changes referred to above are permanent, hereditary and genotypic, can best be determined by breeding the various strains. This means that they must be made to reproduce sexually or in some way which involves nuclear and cytoplasmic fusions followed by reduction divisions, thus giving the opportunity for orderly segregation, if there be such in any particular case. The subject of the present paper is somewhat apart from this question, yet it has a direct bearing on it as illustrating a curious effect or influence of the culture medium on the type of fruit body formed.

Pezizella Lythri (Desm.) Shear & Dodge¹ is one of the most widely distributed and much named spot disease fungi. Since the publication of the paper the writer has observed at various times the degree of pathogenicity of the fungus on different hosts. As a rule it is not one of the destructive spot diseases. It is however, occasionally very severe in its attacks on the host. Certain wild blackberries and dewberries in Florida and Georgia were seen to be practically defoliated as the result of attacks by this species. At one place in the mountains of North Carolina where *Galax* and the rare *Shortia* were growing abundantly their leaves were badly scarred and spotted. Figures A to C in plate 20 show the characteristic types of injury. The large black pycnidia of the *Ptilidium* or *Sclerotiopsis* stage were very abundant, scattered over the areas killed by the parasite. *Pezizella Lythri* is one of those so-called "pleomorphic" forms which develops two different kinds of asexual fructifications both of which take on various aspects depending on the species of host attacked, and other environmental conditions. This peculiarity may account in part for the pycnidial stage having been referred to *Ceuthospora*, *Leptothyrium*, *Sporonema*, *Sclerotiopsis* and *Ptilidium* under at least 13 specific names. The sporodochial stage has been placed in 7 different genera under at least 10 other specific names. Shear and Dodge (l.c., pl. 8) pointed out that this latter stage is especially apt to vary with conditions. The delicate flesh-colored patellate *Hainesia* sporodochium often becomes, when, grown on apple fruit, a black pycnidium-like structure with a wide ostiolar opening through which is extruded a mass of spores simulating a cirrus (l.c. pl. 8, fig. 6). Although the *Ptilidium* (*Sclerotiopsis*) and *Hainesia* spore forms may be found side by side on a leaf or stem, the one never is a modification of or a development from the other. They are distinct morphological units represented by a separate set of genetic factors.

During the time studies on *Pezizella* were being carried on the writer had in culture a species of the form genus *Chaetomella* collected on rose and also on wild blackberry. The fungus is

¹Shear, C. L., and Dodge, B. O. The life history and identity of "*Patellina Fragariae*," "*Leptothyrium macrothecium*," and "*Peziza Oenotherae*." *Mycologia* 13: 165-170. 1921.

described as a new species, *C. raphigera*, by Miss Marjorie E. Swift on another page in this issue of Mycologia. Its sexual stage is unknown and no species of the genus has been connected with a perfect stage. Following the development of the asexual fruit bodies of *Pezizella Lythri* and *Chaetomella raphigera* one finds certain striking resemblances as well as marked differences. The reader is referred to the paper previously cited and to a later one by the writer ² where a full discussion of the development and morphology of the three kinds of fructifications of the former species will be found illustrated.

Cultured on blackberry stems in tubes the pycnidium of *Chaetomella* originates beneath the epidermis. A mound of tissue without particular form or orientation of hyphal elements breaks its way through the epidermis. In cultures on agar the mycelium forms a tough mat or skin-like layer over the surface. At the point of origin of a pycnidium a foot structure, enlarged above, first develops. From this point on, the stages in pycnidium formation on agar and on stems are much the same. From the top end of the stalk there begins an upward growth of slender colorless hyphae ranging outward and upward, then drawing together at their tip ends to form an elongated dome (PLATE 21, A). The ends of the hyphae come together not at a point, but, owing to the form of the growing fruit body, in a line which extends lengthwise over the top of the dome, forming a sort of suture which becomes more distinct as the pycnidium reaches maturity (PLATE 20, E AND G).

During this interval the stalk continues to thicken especially above where it spreads out. The body of the young pycnidium is now plainly raised above the surface of the substratum. Next, one sees in section a differentiation of the slender upward growing hyphae, previously mentioned, into two distinct regions, an outer and an inner (PLATE 21, B). The outer tissue consists of some ten or a dozen layers of elongated narrow cells tending to become brick-shaped. This is to become the wall which will undergo further differentiation. The space within the bounding wall is filled with the long slender undifferentiated hyphae whose free tips all but come together beneath the ridge of the dome wall.

² Dodge, B. O. Origin of the central and ostiolar cavities in pycnidia of certain fungous parasites of fruits. Jour. Agr. Research 23: 743-759. 1923.

Except perhaps for a small opening just beneath the ridge there has been as yet no opening corresponding to a pycnidial cavity.

Next begins a differentiation of the wall tissue. Long before the pycnidium has reached full size the comparatively short and stiff setae (PLATE 21, C) which characterize this species have begun to grow out from the outer layer of wall cells. This outer wall is two or three cells thick and the cells remain hyaline for a long time. About the time the pycnidium is attaining its full growth, the middle wall begins to turn brown. It consists of two or three layers of thick-walled brown cells (PLATE 21, D). This layer finally cuts down beneath the pycnidium and forms the line of separation when the body of the mature pycnidium is detached from its stalk, which can be done readily. Along a line right beneath the ridge of the dome the inner row of these thick-walled cells appears to be wanting and the cells of the outer row buckle outward. This is, no doubt, a provision for a line of weakness along which the wall may rupture in spore discharge later.

When we consider that the spore-bearing part of the pycnidium is readily dislodged from its stalk and that it is armed with stout stiff setae which are often hooked, it looks as though nature had provided a way for the whole fruit body to become attached to insects for transportation, after which by dehiscence the spores would be spread locally.

The third and inner wall of the pycnidium consists of about four or five layers of small thin-walled cells which line the cavity completely except for the basal sporogenous cushion. It is from these cells at the sides and also well toward the top one sees some thin colorless hyphal threads extending into the cavity. Spore formation does not begin usually until the pycnidium has become colored dark brown. Some of the hyphae ranging upward from the basal cushion undergo disorganization and furnish quantities of degeneration products which appear like oil droplets in crushed mounts. The minute bodies seen in figure C of plate 21 are the cut ends of these thread-like hyphae which completely fill the central region. No spores have been formed up to this time. Figure B on this plate is of a section through the center of a much younger pycnidium and shows these

hyphae in longitudinal view. Similar hyphae are seen in figure *F* which is of another type of structure to be described presently. While in a mature pycnidium the sporophores are rather short filaments, once or twice branched in incomplete whorls, some spores or spore-like bodies are formed precociously from these long filaments which are beginning to break up. In an old pycnidium the cavity is quite filled with spores and one sees very few filaments remaining. The sporogenous tissue at the base is usually a flat cushion (PLATE 21, *E*). Occasionally it appears rather low conical in section, however.

It has been noted (p. 170) that *Pezizella Lythri* develops two kinds of asexual fructifications, one of which is a fleshy patellate sporodochium. When one grows *Chaetomella* in culture on a very soft agar well supplied with nutrient, or on blackberry stems in tubes tightly plugged and containing water at the bottom to provide a saturated atmosphere, pycnidium formation is sometimes abnormal. That is, instead of forming a reniform dark colored closed pycnidium, the spore bearing structure develops into a beautiful white patellate sporodochium with a crenulate margin bearing the straight or hooked setae, now uncolored (PLATE 20, *II-K*, PLATE 21, *F, G*). Such structures are open from the first and spore formation begins rather early. The spores accumulate in a mass or mound (PLATE 20, *K*) and in this stage, except for the setae, resemble exactly the *Hainesia* form of *Pezizella* described by Shear & Dodge (l.c. *pl. 8, fig. 2*). By manipulating the conditions as to humidity, one can stop spore formation in what would have otherwise been an open type and induce the formation of a wall up over the top of the structure which will then go on to maturity as a normal pycnidium, except that it will not have as many setae at the top of the dome. The central ridge likewise will not be distinguishable.

Sometimes, but not always, when the normal pycnidium, as well as the open type, develops beneath the surface of the agar, no setae are formed. On the other hand, one can often find setae arising indiscriminately from hyphae all over the surface of the agar without regard to the beginnings of fruit bodies.

The writer² has described the formation of the pycnidial cavity in three different types of pycnidia. *Chaetomella* illus-

trates a fourth type where the central region is filled from the first with free-growing hyphal elements not organized into a compact tissue. Space for spore formation and storage is provided by disorganization of these central filaments and, as a result, predigested food is provided for spore development.

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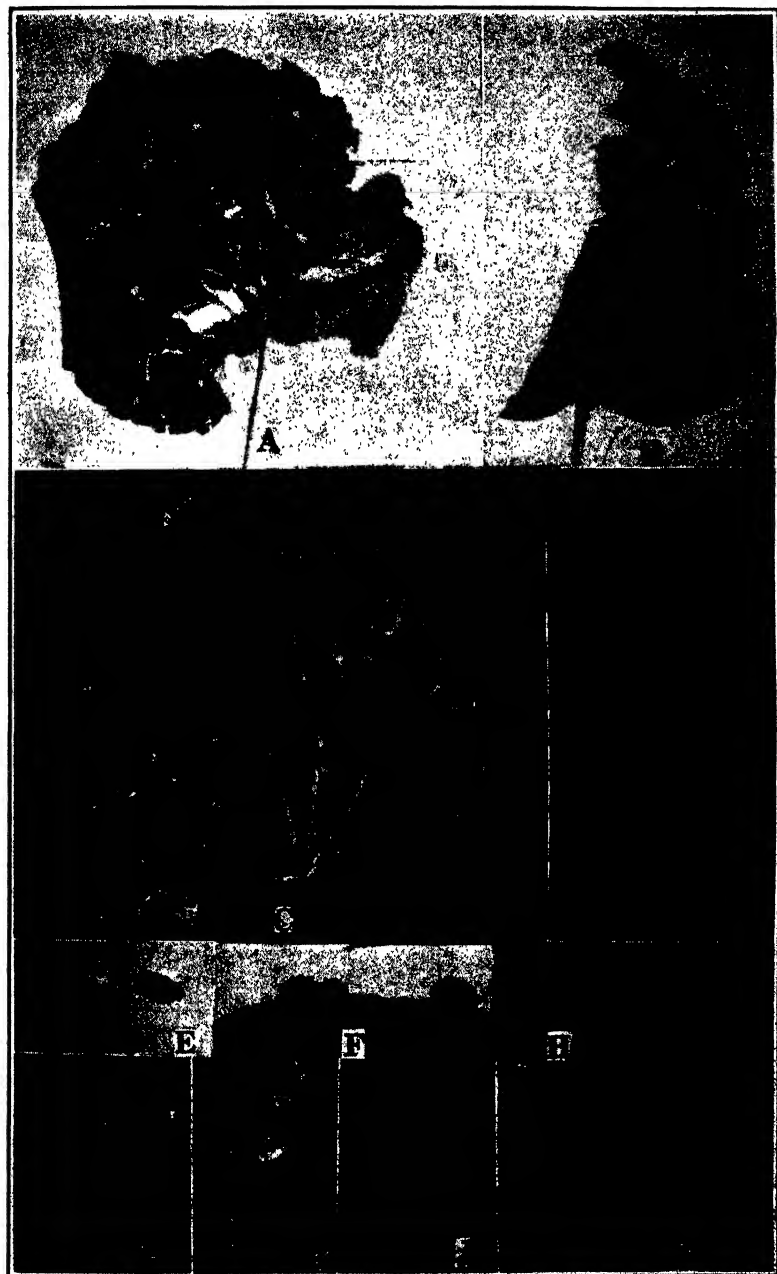
EXPLANATION OF PLATES

PLATE 20. *A to C, Pezizella Lythri; D to K, Chaetomella raphigera*

A, *Ptilidium* (*Sclerotiopsis*) stage of *Pezizella Lythri* on leaf of *Galax*. Photograph natural size from dried specimen; *B*, leaf of *Shortia* showing destructive effect of infection by this fungus, slightly enlarged; *C*, leaf of *Galax* showing characteristic type of leaf spot on living leaf; *D*, pycnidia of *Chaetomella raphigera* grown on agar. Note setae bearing droplets of water; *E*, pycnidia showing raphe over the dome; *F*, showing stalk on pycnidium; *G*, pycnidia just beginning to turn brown, raphe marking and bristles distinct; *H*, *I*, and *J*, white patellate open types of fructifications developed on soft agar. Spore masses were removed before photographing to show crenate margins and setae, visible in *I* above; *K*, masses of spores on open types. Black bodies are closed types induced to form later by drying agar.

PLATE 21. *Chaetomella raphigera* Swift

A, Vertical section through very young pycnidium slightly to one side of central axis, showing subepidermal origin, stalk, and free-growing hyphae in the pycnidial cavity. Base of seta at upper left; *B*, section through center of young pycnidium showing differentiation into wall tissue and central cavity filled with slender hyphae converging beneath the dome; *C*, section through two pycnidia arising from a branched stalk. Pycnidial wall differentiated into three tissues. Broken setae show on lower pycnidium and curved seta at *X*; *D*, section showing three wall-tissues and origin of two setae which were broken away in sectioning; central cavity filled with thread-like hyphae cut ends of some of which can be seen. Spore formation just beginning; *E*, similar to *D* out shows nature of stalk tissue which is being cut off by sclerotized middle-wall tissue; *F*, section of open type of fructification grown on blackberry stem in tube under humid conditions. Wall cells will not be sclerotized. The structure is open from the first and will remain so. Stalk apparent. Central region shows thread-like hyphae ranging upward. Conidia being formed from sporophores at base of cavity; *G*, open type of fructification grown on soft agar. A patellate sporodochium, open from the beginning. This is one arm of a double fruit body similar to the one shown in *C* except that it is an open type; note seta left center below. Short branched sporophores have developed masses of spores. Compare with figs. *H* to *K*, plate 20.



PEZIZELLA LYTHRI AND CHAETOMELLA RAPHIGERA



CHAETOMELLA RAPHIGERA

THE RELATIONSHIP BETWEEN THE BLUE-STAINING FUNGI *CERATOSTOMELLA* AND *GRAPHIUM*

CAROLINE T. RUMBOLD

The question of whether *Graphium* is an imperfect stage of a *Ceratostomella* that stains the sapwood of hardwoods and of softwoods has caused some controversy. In the United States the two organisms are generally assumed to be distinct, independent fungi, whereas in Europe a relationship is recognized.

In this country Von Schrenk,¹ who was the first to report a fungus blue-staining pines, described *Ceratostomella pilifera*, from cultures made by Hedgcock, without mentioning *Graphium* either on the host trees or in the cultures. Hedgcock,² continuing the study of the blue-staining fungi in pure culture, always found that *Ceratostomella* and *Graphium* could be separated by careful isolation methods. The many systematic descriptions given in Saccardo of *Ceratostomella* collected in the United States fail to mention *Graphium* as an imperfect form of the fungus. Rumbold³ cultured some fungi found in blue-stained wood, among which was a *Graphium* isolated from a deeply stained board of red gum (*Liquidambar styraciflua*). In contrast with the usual results, some of the cultures started from this *Graphium* developed perithecia after they were about three weeks old, but unfortunately when this work was carried on the time available was insufficient to investigate satisfactorily the

¹ Hermann von Schrenk. "The 'Bluing' and the 'Red Rot' of the Western Yellow Pine with Special Reference to the Black Hills Forest Reserve." Bureau of Plant Industry, U.S.D.A. Bul. 36, 1903.

² Geo. G. Hedgcock. "Some Wood Staining Fungi from Various Localities in the United States." Jour., Myc. 12: 204-210. 1906. "Studies upon some Chromogenic Fungi which Discolor Wood." Annual Report of the Missouri Botanical Garden 17: 59-114. 1906.

³ Caroline Rumbold. "Über die Einwirkung des Säure- und Alkaligehaltes des Nährbodens auf das Wachstum der holzzersetzenden und holzverfärbenden Pilze; mit einer Erörterung über die systematischen Beziehungen zwischen *Ceratostomella* und *Graphium*." Naturwissenschaftliche Zeitschrift für Forst- und Landwirtschaft 9: 429-467. 1911.

possibility of a relationship between the *Graphium* and the *Ceratostomella*. The conclusion from the evidence heretofore available thus is that in this country the two fungi grow independently of each other; it apparently would be an exception if a connection were found. Further evidence of a confirmatory nature will be presented in this paper.

In Europe Münch⁴ was the first worker to study blue-stain fungi in pure culture. He described and named *Ceratostomella Piceae* and *C. cana*, Pyrenomycetes whose cultures produced a *Graphium* as a conidial form. He considered the *Graphium* identical with Corda's *Graphium penicillioides*. MacCallum⁵ found and described *C. Piceae* in England. Lagerberg, Lindberg, and Melin⁶ collected *C. Piceae* in different regions in Sweden. They observed that, when cultivating this fungus from ascospores, the culture always produced *Graphium* stalks before it developed perithecia. Often the perithecia failed to appear if the culture was weak.

During the four years that the writer has been studying cultures of the blue-stain fungi of the United States, a fairly large number of samples of blue-stained hardwoods and softwoods has been collected from various parts of the country. The record of the cultures from these specimens shows that they produced a single fungus, either a *Graphium* or a *Ceratostomella*, fully as often as they developed *Graphium* and *Ceratostomella* together. The two could be isolated and cultured for generations as separate fungi. In other words, the species of *Graphium* in general are not imperfect stages of *Ceratostomella*.

In one case only has the author seen a connection between the two fungi; a *Ceratostomella* that had a *Graphium* as a conidial form of fruit was found growing on a rough-surfaced birch board (*Betula* sp.) 1½ inches thick collected in a lumber yard in Wisconsin. For three years an effort was made to separate the two

⁴ Ernst Münch. "Die Blaufäule des Nadelholzes." *Naturwissenschaftliche Zeitschrift für Forst- und Landwirtschaft* 5: 531-473. 1907; 6: 32-47, 297-323, 1908. 33 figs.

⁵ B. D. MacCallum. "Some Wood Staining Fungi." *The British Mycological Society Transactions* 7: 231-236. 1922.

⁶ T. Lagerberg, G. Lindberg and E. Melin. "Biological and Practical Researches into Bluing in Pine and Spruce." *Svenska Skogsvårdsforeningens Tidskrift* 2: 145-272, 561-739, 88 figs. 2 colored plates. 1927.

forms, *Ceratostomella* and *Graphium*, from this specimen by means of the poured-plate method. Ascospores were sown on malt agar in Petri dishes and the young colonies were transferred to fresh Petri dishes before fruits had appeared. *Graphium* stalks always appeared first and later *Ceratostomella* perithecia. One could not be sure, however, that the colonies started from ascospores only for, since the spores of *Ceratostomella* have a gelatinous covering, it is possible foreign conidia may have been sticking to them. These spores are too small to be observed until they have swelled and germinated. During the summer of 1927¹, 23 single-spore cultures were made. After the ascospores had germinated secondary conidia developed; then *Graphium* fruits appeared. Every one of the 23 lines produced *Graphium* stalks. In a month 4 out of the 23 lines produced perithecia. When three months old the *Graphium* heads in the cultures of these 4 lines were dry and the *Ceratostomella* fruits fresh. Eight months after the cultures were started 9 of the *Graphium* lines were becoming sterile, that is, they no longer developed *Graphium* stalks. This behavior is similar to that described by Münch for *C. Piceae* and *C. cana*, and by Lagerburg for *C. Piceae*.

A possible reason is suggested for this fact that only 4 out of 23 of the single spore cultures produced perithecia. It may be that the cultures which produced both *Ceratostomella* and *Graphium* came from binucleate spores and the other 19 from uninucleated spores which were plus or minus and thus incapable of perithecial formation. This could be tested by mixing some of the 19 lines.

It is an interesting phenomenon that this *Ceratostomella* and *Graphium* strain has been fruiting on malt agar slants for more than three years, during which the cultures have looked normal. The method of starting new cultures has generally been to gather the globules of ascospores from the tips of the perithecia on a platinum needle and then transfer them to fresh agar medium.

¹ The work of making the single spore cultures was done by Miss Beatrice Nevins, graduate student in botany, University of Wisconsin.

Ascospores from a single perithecium were separated by shaking in malt solution and left over night in the solution. They were then sown on gelatin plates, where they were found to have germinated. Isolated spores were removed to Van Tieghem cells and there grown further under observation before acceptance as true single spores.

When *Graphium* conidia were used as the inoculum, *Graphium* stalks appeared shortly after the conidia were sown. Before the young culture produced perithecia, *Graphium* conidia were again transferred to fresh agar slants. Apparently a *Graphium* culture unmixed with *Ceratostomella* was procured, but the cultures after about the fifth generation ceased to fruit, that is, to produce *Graphium* stalks. The mycelium was cream-colored. This whole experiment was repeated several times. The strain when perpetuated through *Graphium* conidia seems unable to continue growth in artificial culture.

The formation of the fruits was influenced by the condition of the substratum. In agar slants the top or driest portion of the culture developed *Graphium* while the middle of the slant, which is moister, was usually occupied by *Ceratostomella* perithecia. The mycelium was light-colored when young, and gray, brown, or black where perithecia had formed.

PERITHECIA

The perithecia are similar to those of *Ceratostomella pilifera* (Fries) Winter. Although the bases have brown septate hairs scattered over them, they themselves are black. In shape each perithecium is globular, and often is flattened at its base. Their diameters average 148μ ⁸; with a sextile range for those under favorable circumstances (at the middle of the slant), of 136 to 172μ ; their average height is 140μ , sextile range 136 to 172μ . The dimensions of their beaks are as follows: Average length, 1156μ ; sextile range 1040 to 1403μ ; average diameter at the base, 39μ and at the tip 9μ . In addition, the hyaline bristles at the tip of the beak are 6 to 30μ long. Asci are 6μ by 5μ , while the slightly curved ascospores average 5μ by 2μ . The secondary conidia resemble those found in *C. pilifera* cultures.

GRAPHIUM

The black bases of the *Graphium* stalks that develop a few days after the ascospores germinate shade into brown near the tips of the stalks. The ends of the hyphae that bear the hyaline

⁸ The averages reported in this paper are each based on 20 or more measurements, from several different cultures, and representing top, middle, and base of slant. The sextile range is that remaining after the highest sixth and the lowest sixth of the values have been discarded.

conidia are white when young, but are cream-colored by the time the perithecia are forming. This *Graphium* resembles *Graphium penicillioides*, which Münch associates with *Ceratostomella Piceae*.

The stalks average $645\ \mu$ in length, with a sextile range of 442 to $885\ \mu$; the widths of the stalks average $48\ \mu$ and sextile range 20 to $89\ \mu$. The primary hyaline conidia average $3\ \mu$ by $1\ \mu$.

A common sight in cultures is aerial strands of mycelium on which *Graphium* stalks intermingle with secondary conidiophores. Münch illustrates this formation in his description of the *Graphium* connected with *Ceratostomella Piceae*. Hedgcock² remarks about his own *Graphium* cultures, "It is also quite probable that in all species of *Graphium* the primary conidia are formed in the head precisely as the secondary conidia are formed in the open and that the two forms of conidia are morphological equivalents. In most of the species studied many graduations were found between a head on a stalk of a single colored filament and heads on stalks of two to many filaments."

SUMMARY

The connection between *Ceratostomella* and *Graphium* shown in cultures in which both appear suggests the possibility that *Graphium* may be in a state of evolution; perhaps at one time it regularly formed the imperfect stage of *Ceratostomella*. In the United States the cases in which this connection can be demonstrated seem to be few; in Europe they are more frequent.

The fungus that produces both *Ceratostomella* and *Graphium* is regarded by the writer as a strain of *Ceratostomella pilifera* (Fries) Winter, which is one of the commonest blue-staining fungi in lumber yards. Although there are many strains of this species that vary in minor details, such as the size and the shape of their perithecia and their habits of growth on and in the sapwood of hardwoods and of softwoods, the strains are not so different that they should be classified as distinct species. A careful study of the fungi grown under cultivation has convinced the writer that there is no line that can be drawn between one strain and another.

OFFICE OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
IN COÖPERATION WITH THE
FOREST PRODUCTS LABORATORY

A NEW VARIETY OF ACROTHECIUM OBOVATUM

BAILEY K. ASHFORD AND RAFFAELE CIFERRI

(WITH 2 TEXT FIGURES)

Origin of strain: A saprophyte of the human skin.

Collection number: 1519,² Ashford.

Cultural and morphological characteristics: On Sabouraud's proof agar, the colony is at first whitish, afterwards whitish with gray shading. The border is delicate, evanescent, with creeping vegetative hyphae. The surface has a woolly appearance and is irregularly furrowed. It presents at times drops of water of condensation which are colored black or dark-brown. Its development is quite slow and normally it fails to extend over the entire surface of the medium. It grows easily on any kind of sugar or peptone-sugar media always with characteristics similar to those described for cultures on Sabouraud's agar. The mycelium is composed of very abundantly and irregularly branched hyphae which are septate, much twisted, and, especially on the surface, where the felt-like duvet is formed, it is of a quite even caliber and sub-hyaline or even hyaline. The branching of hyphae is not uniform; frequently the branches are lateral, coming off in pairs, one on each side, or alternately (FIG. 2, a). The hyphae which are found in the upper layers of the medium or which adhere to the surface are frequently composed of almost hyaline, toruloid articles which can be interpreted as chlamydo-spores. They are usually intercalary, rarely terminal. This mycelium has a greater caliber than that of the surface type. The moniliform chains are of very varied aspect. Without explaining in detail its morphological aspect, which is similar to that described in cultures of many Dematiaceae, we refer the reader to figure 2, b, where some of them are sketched. Frequently, although not uniformly, the deep mycelium and that attached to the surface branches and becomes densely entangled forming a loose plectenchymatic structure. Not unusually

mycelial rhizoides in the form of nodular bodies are seen, with multiple branches which proceed from one sole point, or from a short slip of a primary hypha which grows down into the agar or spreads out superficially. One of these rhizoid elements is depicted in figure 2, *c*.

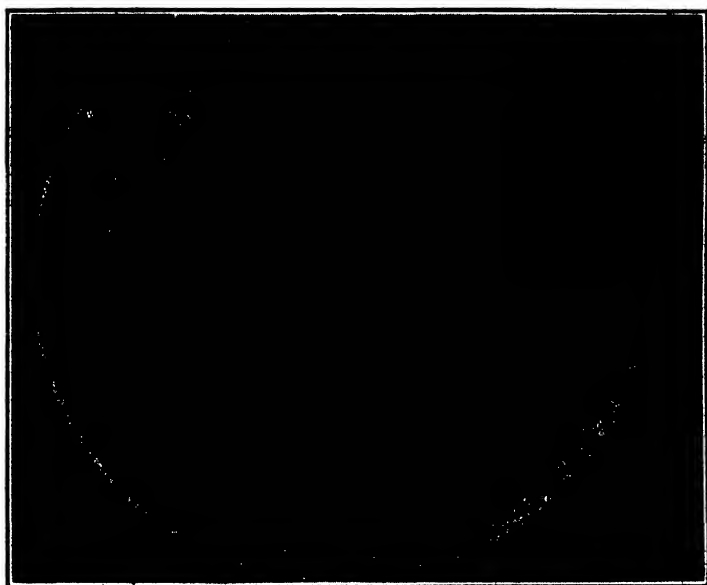


FIG. 1. Colony of *Acrothecium obovatum* Cooke & Ellis var. *subcapitulatum*, on Sabouraud's proof-agar, ten days old, $\frac{3}{4}$ natural size.

The superficial mycelium first and the deep mycelium later, produces conidiophores, although more abundantly the first than the second. They are simple or branched, short or long, but the simple and long variety predominate and the branches are generally fertile. They are straight or irregularly sinuous; rarely twisted; prostrate or semiprostrate, rarely erect; subhyaline highly septate. Their caliber is approximately from 2 to 3 microns. Their base is not bulbous or spherical, nor is the free extremity, which, however, may at times be almost imperceptibly swollen.

The conidia are acrogenous but on rare occasions can be found not at, but near the end of the hypha. They are solitary or

vertisillate but their number is extremely variable. In certain zones of the culture the unisporous conidiophores predominate and in others the polysporous, the latter, however, being less common than the former. But we ought to add that the production of conidia is not very abundant. The *Verticillia* are compound consisting of from two to five elements, usually from two to three. Their shape is from oval or sub-oval to elliptical, rarely subclavate or fusiform, and, in the latter case, in certain instances, scythe-shaped. Their color is a more or less dark smoky-brown. If the conidium is uniseptate, both compartments may have the same color, or one, generally the apical, is of a lighter color, the other being darker. If the conidium has two or more septa the central cell is frequently darker than the basal and apical. This fact has been already pointed out in the description of other species of this genus. The number of the septa varies from none to three, but in well-developed conidia they are usually two or three, rarely one. Their size varies between fairly wide limits but is generally from 20 to 28 by 6 to 8 microns. The episporium is normally well in evidence and very little if at all constricted at the site of the septa. These septa are straight or, more frequently, curved. The insertion of the conidia upon the conidiophore is direct.

The fructification of this fungus is generally scanty, even in media which are especially favorable. The fertile layer is usually that in direct contact with the agar. The conidia appear at first in clavate form at the extremity of a hypha or its branch, and are subhyaline and continuous; they grow rapidly, becoming darker and forming their septa. The mature conidia germinate with some difficulty, either in hanging drop or in microculture on solid media. They generally emit a germinative tube from the central compartment, more rarely two, one from each one of two compartments that are near each other.

SYSTEMATIC POSITION

This fungus belongs to the Dematiaceae Macroneae Acrotheciae, and, in this tribe, to the genus *Acrothecium* Preuss (6, 7) emend. *Saccardo* n.p. nec Corda.

The history, the signification, and the nomenclature of this genus is not yet clear. A good study of it has recently been

made by Mason (5) from the standpoint of *A. lunatum* Wakker and summarized by one of the authors (1), in studying *A. nigrum*. In the latter work the conclusions of Mason were temporarily accepted as valid, with the genus and its present designation, and to these works we refer the reader for more details.

As one of us had already studied the organism, (1) in the case of *A. nigrum*, our strain here under consideration offers in culture notable variations, approximating now *Brachysporium* Sacc., now *Spondylocladium* Mart., now *Napicladium* Thüm. Besides, the uniseptate conidia approximate *Cordana* Preuss, and, the continuous conidia, *Acrotheca* Fuckel.

Among the species belonging to the sub-genus *Eu-Acrothecium* Sacc. with dark conidia, the species which most resembles our own is *A. obovatum* Cooke & Ellis (2) which lives on the branches of the tree or in the wood, this cosmopolitan species being known in Northern, Central and Southern Europe and in North America.

However, there exist some differential characteristics, although small and of secondary importance, which could be attributed to the influence of the habitat on our strain (culture on artificial media) and to that working upon the species of Cooke and Ellis who only made their study of the organism as it lay in its normal habitat, wood, and who made no cultures. In order to summarize clearly the differential characteristics between our strain and that of *Acrothecium obovatum* as defined by Saccardo (8), Lindau (4) and Ferraris (3), we have constructed the following table:

<i>Acrothecium obovatum</i> Cooke & Ellis	Strain 1519 ²
Black tufts.	White tufts with grayish shading.
Conidiophores 150×5 microns.	Length of conidiophores very variable.
Conidia in groups of from three to five.	Conidia isolated, or in verticillate groups of two or three, rarely to five.
Conidia bi-septate, somewhat constricted at site of the septa.	Conidia bi-septate; sometimes none; rarely three, not constricted at site of septa, with a darker color in the intermediate compartment.
Conidia sub-ovoid; 18 to 20 by 7 to 8 microns.	Conidia sub-ovoid but variable, even forming scythe-shapes; 20 to 28 by 6 to 8 microns.

The other characteristics are identical except the microscopic not possible to compare.

On account of these differences it seems justifiable to create a new variety *ad interim* which has only a temporary value. A monographic study of this genus, which would make comparative studies on the species on natural media and the relative importance of variations of these species in different media and under varied conditions, will definitely determine the systematic value of this variety.



FIG. 2. *Acrothecium obovatum* Cooke & Ellis var. *subcapitulatum*. (a) Hypha with its branches; (b) Serial intercalary chlamydospores; (c) A nodular body composed of rhizoides; (d) Different forms and types of conidia and conidiophores. Sketched by camera lucida. Object 4, Ocular .25 B. & L.

We present the diagnose of the new variety:

Acrothecium obovatum Cooke. & Ellis, var. *subcapitulatum* Cif. & Ash, var. nov.

Differs from type by the color of the colony (white with gray shading); conidiophores very variable in length; two to three verticillate conidia, rarely five, generally bi-septate, rarely from one to three septa or even none; conidia not constricted, central compartment darker than the others, ovoid, elliptical, even clavate, rarely fusiform or scythe-shaped, from 20 to 28 by 6 to 8 microns.

Habitat: Saprophyte of human skin, April 15, 1928, San Juan, Porto Rico, recovered from skin by Dr. Bailey K. Ashford.

Summary: A discussion of the cultural and morphological

characteristics of a new variety of *Acrothecium obovatum* Cooke & Ellis.

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CULTURAL STUDIES OF SOME SOIL FUNGI¹

E. L. LeCLERG

In a study of soil fungi of Colorado a survey was made of the fungus flora of our irrigated and non-irrigated soils. During this study it became evident that some criterium besides morphological characters was necessary for the accurate determination of the fungi isolated. It was thought that a knowledge of the cultural characters would be of assistance in the identification of soil forms. Most of the descriptions in the past have been based almost entirely upon morphological characters. Since these characters are extremely variable, no trustworthy separation is possible unless a more stable bases of classification can be established.

A review of the literature regarding the cultural characteristics of soil fungi as an aid to identification shows that data is scarce regarding many of the groups. Extensive studies of growth on various media is largely limited to specific groups or genera, such as Thom (9) and Woeltje (11) on the genus *Penicillium* and Thom and Church (10) and Blochwitz (3) on the *Aspergilli*. Abbott (1, 2) found that fungi are not as specific in their reaction to carbohydrates as are bacteria and these substances can not be used in making specific determinations. Although it is doubtful if species can be separated on cultural characters alone, yet this information will be of assistance together with morphological characters in the identification of soil forms.

It is the purpose of this paper to make a study of the cultural characters of fungi which have been found to occur in Colorado soils.

The fungi cultivated during this work have been isolated from time to time over a period of two years. These do not, of course, constitute the entire fungus flora of Colorado soils, but are fairly

¹ The author takes pleasure in acknowledging his indebtedness to Dr. L. W. Durrell for advice regarding the manuscript and to Dr. J. C. Gilman, Iowa State College for help in identifying the species and for valuable criticism of the paper.

representative of the eastern part of the state, since they were obtained from about four hundred samples which were collected from various localities in this section.

The following species of soil fungi were isolated and constitute the basis for this work: *Rhizopus nigricans* Ehrenb.; *R. arrhizus* Fischer; *R. elegans* Eidam; *Mucor glomerella* (Bainier) Lendner; *M. lausannensis* Lendner; *Cunninghamella verticillata* Paine; *Trichoderma lignorum* (Tode) Harz; *Aspergillus minutus* Abbott; *A. flavus* Link; *A. terreus* Thom; *A. Wentii* Wehmer; *A. candidus* Group, Thom & Church; *A. orchraceous* Wilhelm; *Penicillium expansum* (Link) Thom; *P. stoloniferum*; *P. viridicatum* Westling; *P. commune* Thom; *P. purpurogenum* Stoll; *P. humicola* Oudemans; *P. citrinum* Thom; *P. chrysogenum* Thom; *P. digitatum* Sacc.; *Sporotrichum pruinosum* Gilman & Abbott; *Trichothecium roseum* Link; *Hormodendrum cladosporioides* (Fresen.) Sacc.

METHODS AND MEDIA USED

Observations of cultural characters were made four to seven days after inoculation unless otherwise stated. The fungi were grown in Petri dishes and incubated at 22-25° C.

The media used are given below with the method of preparation of each:

Czapek. Cane sugar 30g; NaNO₃ 2g; K₂HPO₄ 1g; MgSO₄ 7H₂O 0.5g; KCl 0.5g; FeSO₄ 0.01g; agar agar 15g; distilled water 1000cc.

Gelatin. A fifteen per cent gelatin medium was prepared by melting 150 grams of gelatin in a double boiler and enough water added to make one liter. This liquid was filtered and autoclaved.

Potato. To 250 grams of raw, ground potatoes, one-half liter of water was added and heated in a double boiler for one hour. The liquid was then filtered through cheese cloth and made up to a liter. Fifteen grams of agar agar were added, steamed, and autoclaved.

Peptone. Ten grams of Bacto Peptone and fifteen grams of agar agar were added to a liter of water, steamed, filtered, and autoclaved.

Starch. Twenty grams of starch were soaked in some cold

water for one-half hour and enough water then added to make a liter. To this 5 grams of agar agar were added, steamed, filtered, and autoclaved.

Malt Extract. A formula similar to that used by Thom and Church (10) was followed. The method used was to add 100 grams of Puritan Pure Malt Extract to 1000cc. of hot water. Fifteen grams of agar agar were added and the entire liquid steamed, filtered, and autoclaved.

Waksman's Medium. This medium was used to cultivate the fungi on the five sugars, maltose, dextrose, d-mannose, levulose, and inulin. The formula used is as follows: sugar 10g; peptone 5g; K_2HPO_4 1g; $MgSO_4 \cdot 7H_2O$ 0.5g; agar agar 15g; distilled water 1000cc.

In all this work chemically pure salts and sugars were used.

CULTURAL DATA OF SOME SOIL FUNGI

The work of Gilman and Abbott (6) was followed for the descriptions of the fungi reported in this paper, except in the case of the form which has not been previously isolated from the soil. The description of this species has been obtained from the papers of investigators who have worked on this form. These papers are cited with the name of the fungus.

Rhizopus nigricans Ehrenb.

Stolons creeping, recurving to the substratum in the form of arachnoid hyphae, which are strongly raised and distant from the substrate and implanted at each node by means of rhizoids. The internodes often attain a length of 1 to 3 cm. and the hyphae are more or less branched. Sporangiophores rarely single, united in groups of 3 to 5 or more, 0.5 to 4 mm. in height by 24 to 42 μ in diameter. Apophyses broad, cuneiform. Sporangia hemispheric 100 to 350 μ . Columellae broad, hemispheric, depressed, 70 μ in diameter by 90 μ in height (max. 250 by 320). Spores unequal, irregular, round or oval, angular, striate, 9 to 12 μ long by 7.5 to 8 μ in diameter, of a grey blue. Zygosporangia are round or oval, 160 to 220 μ in diameter. Exospore brown black, verrucose. Suspensors swollen, usually unequal. Azygosporangia present. No chlamydospores.

CULTURAL DATA

Czapek.—Colonies white, broadly spreading, forming a very loose mat of hyphae and sporangiophores over the substratum. Growth scant. Sporangia production very poor. Reverse colorless.

Peptone.—Colonies same as on Czapek.

Malt.—Colonies same as on Czapek, except that the colonies are much more dense. Growth is rapid and good. Production of sporangia is very abundant.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on Czapek, except that sporangial production is a little more abundant.

Gelatin.—Colonies same as on Czapek, except that sporangial production is more profuse. Rapid liquefaction.

Maltose.—Colonies same as on Czapek, except that growth is rapid and abundant. Abundant sporangia are produced.

Mannose.—Colonies same as on malt agar.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on Czapek.

Dextrose.—Colonies same as on Czapek.

Rhizopus arrhizus Fischer

Differs from *R. nigricans* by being less exuberant. The felt is clearer and it does not extend so far into the substratum. Stolons are little developed and do not form nodes regularly. Rhizoids pale, develop at the nodes and carry sporangia, or are sometimes formed indeterminately. Sporangophores often prostrate, rarely single, forming umbels or corymbs on their stolons. They measure 0.5 to 2 mm. in length. All the branches end in sporangia, of greater or less size. Sporangia spherical 120 to 250 μ in diameter. Columellae spherical, flattened on the apophyses, 40 to 75 μ high by 60 to 100 μ in width, membrane brown, smooth. Spores round or oval, or presenting obtuse angles, greyish brown; walls striated longitudinally, 4.8 to 7 μ by 4.8 to 5.6 μ .

CULTURAL DATA

Czapek.—Colonies white, flat, spreading, only slightly elevated. Production of sporangia very poor. Growth very scant. Reverse colorless.

Peptone.—Colonies same as on Czapek, except that more abundant sporangia are produced, which gives the colonies a black appearance. Growth is rapid.

Malt.—Colonies same as on peptone, except that production of sporangia is even more abundant.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on Czapek, except that sporangial production is better.

Gelatin.—Colonies same as on Czapek, except that hyphae are longer and more broadly spreading. Sporangial production is much more abundant.

Maltose.—Colonies same as on peptone. Hyphae 3 to 5 mm. high.

Mannose.—Growth is more dense than on peptone and sporangial production is more abundant, otherwise similar to that on peptone.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on mannose.

Dextrose.—Colonies same as on mannose.

Rhizopus elegans Eidam (7, 8)

Sporangiophores rarely single, more often united, erect, bearing branches up to 1 to 2 mm. in length, membrane smooth, brownish. Sporangia spherical, small, the terminal sporangia 50 to 70 μ in diameter, the lateral only 33 μ in diameter. They are brown, elegantly ciliated or echinulate. Columellae spherical, smooth, clear brown. Spores spherical, 5 to 7 μ , smooth, clear brown. Zygosporangia unknown.

This fungus has never been reported from soils before. It was found quite abundantly in many soils in Colorado.

CULTURAL DATA

Czapek.—Colonies white, floccose, flat, and only slightly elevated, broadly spreading. Production of sporangia poor. Growth slow and very scant. Reverse colorless.

Peptone.—Colonies same as on Czapek, except that sporangial production is abundant and aërial hyphae are 2 to 5 mm. in height. Growth rapid.

Malt.—Colonies same as on peptone, except that sporangial

production is so abundant that the colonies become very black in color.

Starch.—Colonies same as on Czapek, except that hyphae are 3 to 5 mm. in height.

Potato.—Colonies same as on peptone, except that colonies are more elevated (1 to 1.5 cm.).

Gelatin.—Colonies same as on starch, except that sporangial production is much more abundant. Slight liquefaction.

Maltose.—Colonies same as on peptone.

Mannose.—Colonies same as on peptone.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on peptone.

Dextrose.—Colonies same as on peptone.

Mucor glomerella (Bainier) Lendner

Sporangiophores erect, very branched. Each erect branch terminated by a very large sporangium, below which occur a whorl of 3 to 8 secondary filaments, each terminated by a sporangium. These 3 to 8 filaments give rise in turn to a whorl of 3 to 5 sporangiferous filaments. The aërial mycelial filaments usually end in branches carrying nearly sessile sporangioles. Sporangia spherical, about $70\ \mu$ in diameter, hyaline, becoming sienna color when old. Wall roughened by crystals of calcium oxalate, diffuent leaving a colarette. Columellae variable in shape, hemispheric, cylindro-conic, ovoid, sometimes restricted, inserted at the rather suddenly expanded end of the sporangiophore. Spores round and smooth 2 to $5\ \mu$ in diameter. Aërial chlamydospores round, with thick wall, yellow and spiny. Content oleaginous. Mycelial chlamydospores seemingly submerged but very numerous. Zygosporangia unknown.

CULTURAL DATA

Czapek.—Colonies grayish-white, very broadly spreading, densely floccose, aërial hyphae 8 to 10 mm. in height. Production of sporangia good. Oil globules very abundant. Growth very rapid. Reverse colorless.

Peptone.—Colonies same as on Czapek, except that aërial hyphae are only 5 to 7 mm. in height, and growth is much suppressed and poor.

Malt.—Colonies same as on Czapek, except that aërial hyphae are only about 6 to 8 mm. in height.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on Czapek.

Gelatin.—Colonies same as on Czapek, except that mycelium is more compact and sporangial production is very poor and often inhibited. No liquefaction.

Maltose.—Colonies same as on Czapek.

Mannose.—Colonies same as on Czapek.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on Czapek.

Dextrose.—Colonies same as on Czapek, except that mycelium is not as densely compact.

Mucor lausannensis Lendner

Sporangiophores erect, little branched, bearing laterally one or two groups of branches. These sporangiophores form a fine compact turf, yellowish, 0.5 to 1 cm. high (10 to 14 μ in diameter). Sporangia 40 to 54 μ in diameter, often flattened at the base. The wall is not diffuent; but fragile as in *M. racemosus*, leaving an irregular basal collarette. Columellae oval or spherical, 30 to 40 μ in diameter by 50 μ long. Spores oval, of very different sizes, the smallest 4 by 2 μ , the largest 12 μ long by 6 μ wide. The average size is 8 by 6 μ . They are hyaline, then pale, slowly turning yellowish in mass. Chlamydospores, rather rare, may be formed on either the mycelium or the sporangiophore. They measure on the average 15 by 14 μ , are smooth and granular in content. Zygospores not known.

CULTURAL DATA

Czapek.—Colonies broadly spreading, loosely floccose, white to gray, consisting of network of sporangiophores and mycelium 5 to 8 mm. in height. Mycelium filled with oil globules of varying sizes. Sporangial production very abundant. Growth rapid. Reverse colorless.

Peptone.—Colonies same as on Czapek, except that they are not as broadly spreading, mycelium and sporangiophores are only 2 to 3 mm. in height, and growth is poor and suppressed.

Malt.—Colonies same as on Czapek.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on Czapek.

Gelatin.—Colonies same as on Czapek. No liquefaction.

Maltose.—Colonies same as on Czapek, except that they are more elevated, being 8 to 10 mm. in height, and growth is not as rapid.

Mannose.—Colonies same as on Czapek, except that growth is very slow.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on Czapek, except that growth is very slow.

Dextrose.—Colonies same as on Czapek, except that growth is very slow.

Cunninghamella verticillata Paine

Conidiophores very long, 2 cm. or more by 12 to 14 μ in thickness. Numerous lateral branches are borne at various places along the conidiophores just below the terminal vesicle, forming a number of whorls of two to six lateral branches, each terminating in a vesicle. The conidiophore is more or less swollen at each point of attachment of the lateral branches; lateral branches not exceeding 30 μ in length, their vesicles pyriform or oval, not over 16 μ in diameter. The terminal vesicle globose to oval, about 50 μ in diameter. Spores borne on the terminal vesicle ellipsoid, pointed at the attached end, 10 μ by 13 to 15 μ ; spores borne on the lateral vesicles oval, bluntly pointed at the attached end, 8 to 12 μ in diameter; all spores are finely echinulate, echinulations 1.5 to 3 μ in length.

CULTURAL DATA

Czapek.—Colonies broadly spreading, effuse, grayish white, aërial hyphae very much elevated (8 to 10 mm.). Growth rapid, conidial production good. Reverse colorless.

Peptone.—Colonies same as on Czapek, except that aërial hyphae are only slightly elevated, growth is suppressed and slow.

Malt.—Colonies same as on Czapek.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on peptone.

Gelatin.—Colonies same as on Czapek. No liquefaction.

Maltose.—Colonies same as on Czapek.

Mannose.—Colonies same as on Czapek.

Inulin.—Colonies same as on Czapek, except that spreading is much slower.

Levulose.—Colonies same as on Czapek.

Dextrose.—Colonies same as on Czapek.

Trichoderma lignorum (Tode) Harz

Conidiophores arise as branches of aërial mycelium, septate, up to $70\ \mu$ in height by $3\ \mu$ in diameter, di- or tri-chotomously branched, occasionally forming whorls. Conidial heads up to $10\ \mu$ in diameter; conidia globose to ovoid, smooth, 3.8 to $3.2\ \mu$ in diameter.

CULTURAL DATA

Maltose.—Colonies round, broadly spreading as sterile mycelium, hyalescent, markedly depressed in the center, loosely floccose, prostrate. Fruiting areas appear as tufts, white at first later becoming yellow to green and more abundant near margin of the colony. Growth very rapid. Reverse cream colored.

Mannose.—Colonies same as on maltose, except that they are a darker green, zonate and reverse is white to light green.

Inulin.—Colonies same as on maltose, except that growth is very slow and scarce and slowly spreading. Reverse colorless.

Levulose.—Colonies same as on maltose, except that mycelium is more coarse and zonations are present.

Dextrose.—Colonies same as on maltose, except that mycelium is denser and extends about 3 mm. above the surface. Colonies are zonate.

Aspergillus fumigatus Fres.

Conidiophores short, usually densely crowded, up to $300\ \mu$ (occasionally $500\ \mu$), by 2 to $8\ \mu$ in diameter, arising directly from submerged hyphae or as branches from aërial hyphae, septate or non-septate, gradually enlarged, upward, with apical flash-shaped vesicles up to 20 to $30\ \mu$ in diameter, fertile usually only on the upper half, bearing sterigmata in one series, usually 6 to $8\ \mu$ by 2 to $3\ \mu$, crowded, closely packed, with axis roughly parallel to axis of the stalk; chains of conidia form solid columns up to 400 by $50\ \mu$; conidia dark green in mass, globose, 2 to $3\ \mu$, mostly 2.5 to $3\ \mu$.

CULTURAL DATA

Czapek.—Colonies loosely floccose, spreading, white at first soon becoming light green then dark green with white margin. Growth slow. Spore production good. Reverse colorless to light yellow.

Peptone.—Colonies same as on Czapek, except that spore production is poor.

Malt.—Reverse yellow to light brown, otherwise same as on Czapek.

Starch.—Reverse colorless to light green, otherwise same as on Czapek.

Potato.—Colonies same as on starch.

Gelatin.—Reverse dark green and spore production good, otherwise same as on starch. No liquefaction.

Maltose.—Colonies same as on starch, except that reverse is cream to yellowish green; slightly zonate.

Mannose.—Colonies same as on maltose.

Inulin.—Colonies same as on maltose.

Levulose.—Colonies same as on maltose, except that zonations are absent.

Dextrose.—Colonies same as on maltose.

Aspergillus minutus Abbott

Conidiophores septate, arising as short side branches of aërial mycelium, 30 to 60 μ long by 3 μ in diameter, rarely attaining a height of 125 μ ; also arise directly from substratum, up to 250 μ . Heads round and radiate in young cultures, later tending toward calyptriform; vesicles small, 8 to 18 μ in diameter, globose; sterigmata in two series, primary 4.8 to 6.5 μ by 3.5 to 3.8 μ , secondary 4.8 by 3.2 μ . Conidia globose, verrucose, light greenish brown in mass, 3.2 to 4.5 μ in diameter, mode 3.5 μ .

CULTURAL DATA

Czapek.—Colonies irregular, cottony, white and later becoming dark gray with narrow white margin, slowly spreading, slightly elevated. Growth slow. Conidial production good. Reverse light yellow to orange.

Peptone.—Colonies round, small, flat, white but soon becoming gray then dark brown to black with white margin at time of spore production. Growth slow. Spore production good. Reverse colorless to grayish green.

Malt.—Colonies large, round. Growth rapid. Reverse brown and wrinkled, otherwise same as on Czapek.

Starch.—Colonies same as on peptone, except that reverse is dark.

Potato.—Colonies same as on starch. Abundance of flocculent mycelium present around edges.

Gelatin.—Colonies same as on potato, except that reverse is colorless. Liquefaction slow.

Mallose.—Reverse olive green to light brown, otherwise same as on malt.

Mannose.—Reverse yellow to dark brown, otherwise same as on malt.

Inulin.—Colonies same as on Czapek, except that spore production is very abundant and reverse is light green to dark gray, otherwise same as on Czapek.

Levulose.—Colonies same as on inulin.

Dextrose.—Reverse yellow to delicate green, otherwise same as on mannose.

Aspergillus flavus Link

Conidiophores arise separately from the substratum, 400 to 700 or 1000 μ long by 5 to 15 μ in diameter, broadening upward, walls so pitted as to appear rough or spiny, occasionally granular, gradually enlarging upward to form a vesicle 10 to 30 or 40 μ in diameter. Small heads with small dome-like vesicles and single series of a few sterigmata up to 10 to 15 μ by 3 to 5 μ ; larger heads partly with simple sterigmata, partly with branched or double series or with both in the same head; primary sterigmata 7 to 10 μ by 3 to 4 μ ; secondary 7 to 10 μ by 2.5 to 3.5 μ ; conidia pyriform to almost globose, colorless to yellowish green, sometimes almost smooth, usually rough, varying from 2 by 3 μ , 3 by 4 μ , 4 by 5 μ or 5 by 6 μ in diameter or even larger.

CULTURAL DATA

Czapek.—Colonies large, broadly spreading, round, loosely floccose, moderate elevation, white and soon becoming yellow with white margin. Growth rapid. Spore production poor. Sclerotia quite abundant in old cultures. Reverse yellow and wrinkled.

Peptone.—Reverse colorless, otherwise same as on Czapek.

Malt.—Colonies exceptionally large, consisting mostly of cottony mycelium except in center where conidiophores are produced, elevation 3 to 4 mm. Growth very rapid and abundant. Conidial production good. Sclerotia produced very abundantly in old cultures.

Starch.—Colonies same as on peptone.

Potato.—Colonies same as on Czapek.

Gelatin.—Reverse dark yellow to almost brown. No sclerotia formed, otherwise same as on Czapek.

Maltose.—Colonies same as on malt.

Mannose.—Colonies same as on malt.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on Czapek.

Dextrose.—Colonies same as on malt.

Aspergillus terreus Thom

Conidiophores to 150 or even 250 μ long by 5 to 8 μ , more or less flexuous, with walls smooth, septate or non-septate, with apex enlarged to form a vesicle commonly 12 to 18 μ , occasionally up to 25 μ in diameter, bearing sterigmata usually in two series upon its dome-like upper surface; primary sterigmata 7 to 9 μ by 2 to 2.5 μ ; secondary 5 to 7 μ by 2 to 2.5 μ ; closely packed. Heads becoming solid columnar masses up to 500 μ long by 50 μ in diameter; conidia elliptical to globose, 2.2 to 2.5 μ or even 3 μ in diameter, smooth, in long, parallel, adherent chains.

CULTURAL DATA

Czapek.—Colonies not very large, velvety, round, slowly spreading, slightly elevated, white at first and slowly changing to light cinnamon then to brown. Growth rapid. Spore production abundant. Reverse dark brown.

Peptone.—Colonies small. Oil globules abundant in mycelium. Spore production only fair. Reverse colorless to light yellow, otherwise same as on Czapek.

Malt.—Colonies very large, rapidly spreading, moderate elevation. Growth very rapid, spore production very poor in young cultures. Oil globules very abundant in mycelium. Reverse light yellow and wrinkled, otherwise same as on Czapek.

Starch.—Colonies scarcely rising above substratum. Growth limited to a few aerial hyphae. Spore production very poor and formed in more or less definite rings. Medium colored yellow. Reverse yellow, otherwise same as on Czapek.

Potato.—Colonies ochraceous and zonate, otherwise same as on Czapek.

Gelatin.—Colonies same as on peptone. Slight liquefaction.

Maltose.—Colonies same as on Czapek, except that reverse is bright yellow.

Mannose.—Colonies same as on maltose.

Inulin.—Growth poor, otherwise same as on peptone.

Levulose.—Colonies same as on maltose.

Dextrose.—Colonies same as on maltose.

Aspergillus Wentii Wehmer

Conidiophores 2 or 3 up to 5 mm. long, 10 to 12 or 25 μ in diameter, 1- to 2-septate, walls thick, smooth, enlarged at tips to vesicles varying up to 80 μ in diameter; heads large, yellow to brown, radiate; sterigmata usually in two series, primary varying greatly, 6 to 8 μ , occasionally to 15 μ by 3 to 5 μ ; secondary 6 to 8 μ by 3 μ ; conidia pyriform to globose, usually 4 to 5 μ , less commonly up to 5 or 6 μ ; walls often pitted or furrowed, frequently appearing smooth or nearly so.

CULTURAL DATA

Czapek.—Colonies irregular, slightly spreading, small, white and soon becoming medial bronze with broad white margin. Growth slow. Conidia abundantly produced. Reverse yellow to brown.

Peptone.—Colonies same as on Czapek.

Malt.—Colonies round, rapidly spreading, white but soon becoming grayish yellow and the conidial heads are covered with mycelium. Growth rapid. Reverse orange to brown and wrinkled, otherwise same as on Czapek.

Starch.—Reverse colorless, otherwise same as on Czapek.

Potato.—Colonies same as on malt.

Gelatin.—Colonies same as on Czapek.

Maltose.—Conidial production very abundant, otherwise same as on Czapek.

Mannose.—Colonies same as on maltose.

Inulin.—Colonies same as on maltose.

Levulose.—Colonies same as on maltose.

Dextrose.—Colonies same as on maltose.

Aspergillus candidus Group, Thom & Church

Conidiophores vary with the strain, less than 500 μ long up to 1000 μ or longer by 5 or 10 or 20 μ in diameter, walls thick, smooth; heads white, globose, radiate, varying from large globose masses

200 to 300 μ in diameter, to small heads less than 100 μ in diameter; vesicles typically globose, up to 50 μ in very large heads, fertile over the whole surface; sterigmata typically in two series, primary 5 to 10 μ or even 15 to 20 μ long, secondary 5 to 8 μ by 2 to 2.5 or 3 μ ; conidia colorless, globose, smooth, 2.5 to 3.5 or 4 μ .

CULTURAL DATA

Czapek.—Colonies small, slowly spreading, round, white and soon turning to yellowish cream; surface growth consisting mostly of stalks and heads. Growth slow. Conidial production abundant. Reverse dark brown.

Peptone.—Colonies same as on Czapek.

Malt.—Colonies large, irregular, zonate, with prominent white margin. Growth rapid. Reverse orange to light brown and somewhat wrinkled, otherwise same as on Czapek.

Starch.—Reverse colorless, otherwise same as on Czapek.

Potato.—Colonies same as on Czapek.

Gelatin.—Colonies same as on Czapek. Liquefaction.

Maltose.—Reverse wrinkled, light brown and with concentric rings, otherwise same as on Czapek.

Mannose.—Colonies same as on maltose.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on maltose.

Dextrose.—Reverse not wrinkled and concentric rings lacking, otherwise same as on maltose.

Aspergillus niger Group, Thom & Church

Conidiophores mostly arise directly from the substratum, smooth, septate or non-septate, varying greatly in length and diameter, 200 to 400 μ by 7 to 10 μ or several millimeters long and 20 μ in diameter; conidial heads varying from small, almost columnar masses of a few conidial chains to the more common globose or radiate heads, up to 300, 500 or 1000 μ long; vesicles globose, commonly 20 to 50 μ up to 100 μ in diameter; sterigmata typically in two series, thickly covering the vesicle, primary varying greatly in length, secondary 6 to 10 μ by 2 to 3 μ ; conidia globose, at first smooth, but later spinulose with coloring substance, mostly 2.5 to 4 μ , less frequently 5 μ .

CULTURAL DATA

Czapek.—Colonies large, slightly elevated, broadly spreading, white at first and soon becoming black with broad white margin; consists mostly of stalks and heads. Growth very rapid. Spore production very abundant. Reverse colorless.

Peptone.—Colonies of medium size, flat, of very loose growth, white then black with broad white margin. Growth slow and scant. Spore production poor. Reverse colorless.

Malt.—Reverse wrinkled and growth more profuse, otherwise colonies are same as on Czapek.

Starch.—Colonies similar to those on peptone.

Potato.—Colonies same as on Czapek.

Gelatin.—Colonies similar to those on peptone. No liquefaction.

Maltose.—Reverse colorless to yellow and wrinkled, otherwise same as on Czapek.

Mannose.—Reverse smooth, otherwise same as on maltose.

Inulin.—Colonies same as on mannose.

Levulose.—Colonies same as on maltose.

Dextrose.—Colonies same as on mannose.

Aspergillus ochraceus Wilhelm

Conidiophores variable in length, commonly several millimeters, rough or pitted, bearing large, radiate conidial heads. Vesicles globose 60 to 75 μ in diameter; sterigmata in two series, primary commonly 15 to 30 μ long, although sometimes longer, secondary 7 to 10 μ by 1.5 to 2 μ ; conidia globose to elliptical, smooth or delicately spinulose, yellow, 3.5 by 5 μ or 3.5 by 4 or 4.5 μ .

CULTURAL DATA

Czapek.—Colonies large, round, slightly elevated, white at first and soon becoming ochraceous, spreading with a narrow white margin. Growth rapid. Conidial production abundant. Reverse colorless.

Peptone.—Colonies very small. Growth slow and scant. Spore production fair, otherwise same as on Czapek.

Malt.—Colonies with considerable elevation and spreading with a broad white margin. Reverse colorless to light yellow and wrinkled, otherwise same as on Czapek.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on Czapek.

Gelatin.—Colonies same as on peptone. Rapid liquefaction.

Maltose.—Colonies same as on Czapek.

Mannose.—Colonies same as on Czapek.

Inulin.—Colonies same as on peptone.

Levulose.—Colonies same as on Czapek.

Dextrose.—Colonies same as on Czapek.

Penicillium expansum (Link) Thom

Conidiophores either very short lateral branches of aërial hyphae or very long, 1 mm. or more, arising singly or sometimes grouped to form coremia. Conidial fructifications typically in three stages, 130 to 200 μ by 50 to 60 μ , consisting of one to three primary branches bearing verticils of metulae supporting crowded whorls of phialides; phialides 8 to 10 μ by 2 to 3 μ . Conidia elliptical to globose, 2 to 3.3 μ or 3 to 3.4 μ , green.

CULTURAL DATA

Czapek.—Colonies densely floccose, large, spreading, slightly elevated, white at first soon becoming green or grayish green with margin of sterile, white mycelia. Growth rapid. Spore production abundant. Reverse orange to brown.

Peptone.—Colonies very small, flat, white and very slow to become grayish green. Growth very slow. Spore production very abundant. Reverse colorless.

Malt.—Colonies same as on Czapek, except that reverse is bright orange in color and wrinkled.

Starch.—Colonies same as on peptone.

Potato.—Colonies same as on Czapek, except that reverse is colorless.

Gelatin.—Colonies same as on peptone, except that reverse is colorless. No liquefaction in young cultures.

Maltose.—Colonies same as on Czapek, except that reverse is brilliant reddish orange.

Mannose.—Colonies same as on Czapek, except that reverse is light brownish yellow.

Inulin.—Colonies same as on Czapek, except that fruiting areas are in small round groups and reverse is dark reddish orange.

Levulose.—Colonies same as on Czapek, except that reverse is white to dark yellow.

Dextrose.—Colonies slightly elevated, granular in appearance, large, white and rapidly becoming light blue, with margin of sterile white mycelium. Growth rapid. Spore production good. Reverse reddish yellow.

Penicillium stoloniferum Thom

Conidiophores arise as short branches of aerial hyphae up to $100\ \mu$ or arising separately $300\ \mu$ or more in length. Conidial fructifications 40 to ~~80~~ μ or rarely up to $170\ \mu$ long; usually in three stages, phialides 10 by $3\ \mu$. Conidia slightly elliptical or globose, 2.8 to $3.4\ \mu$, smooth, yellowish green in mass.

CULTURAL DATA

Czapek.—Colonies densely floccose, broadly spreading, slightly elevated, white and soon becoming dark green with white margin. Growth rapid. Spore production abundant. Reverse colorless.

Peptone.—Colonies very small, flat, floccose, slowly spreading. Growth slow. Spore production good. Reverse green or yellowish green, otherwise characters are same as on Czapek.

Malt.—Colonies same as on Czapek, except that reverse is orange to brown.

Starch.—Colonies same as on peptone, except that reverse is colorless.

Gelatin.—Colonies same as on Czapek, except that reverse is colorless to light green. Rapid liquefaction.

Potato.—Colonies same as on starch.

Maltose.—Colonies same as on Czapek, except that reverse is colorless at first and later becomes a faint green.

Mannose.—Colonies same as on Czapek, except that rather indefinite concentric rings are present and reverse becomes pale green with age.

Inulin.—Colonies same as on Czapek, except that growth is slow and reverse is colorless to green.

Levulose.—Colonies same as on mannose.

Dextrose.—Colonies same as on inulin.

Penicillium viridicatum Westling

Conidiophores usually arise from the substratum, but also from aerial mycelium, 75 to $250\ \mu$ by 4 to $6\ \mu$. Heads vary from

loose, almost radiate masses of chains to loose columns. Fructifications in three stages, usually with one primary branch arising laterally, a second primary branch being the prolongation of the conidiophore through the center of the head. Primary branches variable in length, 17 to 30 μ by 3 to 4 μ ; metulae 13 to 20 μ by 3.5 to 4 μ ; phialides 7.5 to 10.5 μ by 2.5 to 3 μ . Some heads have only metulae and phialides. Conidia smooth, globose, light green, 3 to 4 μ in diameter.

CULTURAL DATA

Czapek.—Colonies velvety, round, moderately elevated, restricted in growth; white at first soon becoming leaf green with narrow opaque margin; surface has powdery appearance. Growth slow. Spore production good. Reverse brown.

Peptone.—Colonies same as on Czapek, except that they become grayish green in color.

Malt.—Colonies same as on peptone, except that growth is rapid and spore production poor. Reverse yellow to brown.

Starch.—Colonies small and scattered, otherwise same as on peptone.

Potato.—Colonies same as on peptone.

Gelatin.—Colonies same as on peptone. Rapid liquefaction.

Maltose.—Colonies small, growth rapid and reverse light yellow, otherwise same as on Czapek.

Mannose.—Colonies same as on maltose.

Inulin.—Colonies very small, otherwise same as on maltose.

Levulose.—Colonies same as on maltose, except that reverse is brown and they are covered with floccose mycelia.

Dextrose.—Colonies same as on maltose, except that reverse is dark yellow.

Penicillium commune Thom

Conidiophores commonly 300 μ or less in length, sometimes up to 700 μ . Conidial fructifications commonly 100 to 200 μ in length, in three stages, compact at the base and broadening above, variously branched, with branches appressed; phialides 8 to 9 μ by 3 μ . Conidia elliptical to globose, 3 to 4 μ , smooth, green.

CULTURAL DATA

Czapek.—Colonies spreading, white at first then dull green with broad white margin, moderate elevation. Growth rapid. Spore production good. Reverse yellow to orange.

Peptone.—Colonies very small. Growth slow and scant. Reverse colorless, otherwise same as on Czapek.

Malt.—Colonies same as on Czapek, except that reverse is very dark orange in color and wrinkled.

Potato.—Colonies same as on Czapek, except that reverse is colorless.

Gelatin.—Colonies same as on peptone. No liquefaction in young cultures.

Maltose.—Colonies same as on Czapek, except that reverse is a brilliant reddish orange.

Mannose.—Colonies same as on Czapek, except that reverse is bright yellow.

Inulin.—Colonies same as on peptone, except that reverse is reddish orange.

Levulose.—Colonies same as on Czapek.

Dextrose.—Colonies same as on Czapek, except that reverse is reddish orange.

Penicillium purpurogenum Stoll

Conidiophores arise from aërial mycelium, up to 100 or 300 μ long. Conidial fructifications consist of long, divergent chains, up to 100 μ long, in two stages; metulae 10 to 16 μ by 2 to 2.5 μ ; phialides 11 to 12 μ by 2.5 μ . Conidia elliptical, 3.4 to 3.8 μ or 2 to 2.5 μ , smooth, pale green.

CULTURAL DATA

Czapek.—Colonies closely floccose, to velutinous, white at first and soon becoming yellow to pink; narrow, white margin present. Growth rapid. Spore production good. Reverse dark yellow to red.

Malt.—Growth so rapid and spore production so abundant that a solid mass of spores is formed over the surface, otherwise same as on Czapek.

Potato.—Colonies same as on Czapek.

Gelatin.—Colonies very small and scattered. Growth slow and scant. Spore production fair. Reverse colorless, otherwise same as on Czapek. Liquefaction very slow.

Maltose.—Colonies same as on Czapek.

Mannose.—Colonies same as on Czapek.

Inulin.—Colonies same as on gelatin.

Levulose.—Colonies same as on Czapek. Medium colored red.

Dextrose.—Colonies same as on Czapek.

Penicillium humicola Oudem.

Conidiophores arise both directly from the substratum and from aërial hyphae up to $135\ \mu$ long. Heads loosely penicillate and straggling, breaking up easily; fructifications in two stages, a single verticil of oblong metulae bearing the elongate and slightly pointed phialides; metulae 9.5 to $11.5\ \mu$ by 2 to $3\ \mu$; phialides 6.5 to $8\ \mu$ by 1 to $2\ \mu$; some heads have phialides only. Conidia ovoid to globose, smooth, olive green, 2 to $3\ \mu$ by 1.5 to $2\ \mu$.

CULTURAL DATA

Czapek.—Colonies round, cottony, moderately elevated, white and soon becoming grayish green with broad white margin. Growth rapid. Spore production good. Reverse colorless to yellow.

Peptone.—Growth slow and scanty. Reverse colorless, otherwise same as on Czapek.

Malt.—Colonies same as on Czapek, except that reverse is deep orange and wrinkled.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on Czapek, except that reverse is colorless to light green.

Gelatin.—Colonies same as on potato. Liquefaction.

Maltose.—Colonies same as on Czapek. Zonate.

Mannose.—Colonies same as on potato. Concentric rings present on reverse.

Inulin.—Colonies zonate, otherwise same as on potato.

Levulose.—Colonies same as on inulin.

Dextrose.—Colonies same as on maltose.

Penicillium citrinum Thom

Conidiophores arise separately from submerged hyphae or from mycelium on the surface, usually up to $150\ \mu$ in length* (rarely $300\ \mu$). Conidial fructifications up to $150\ \mu$ in length (rarely $300\ \mu$), in two stages; metulae 16 to $30\ \mu$ by $3\ \mu$, enlarged at the apex to $5\ \mu$ each producing a compact verticil of phialides 6 to $7\ \mu$ by 2 to $3\ \mu$. Conidial chains in columns, a separate column arising from each verticil of cells, so that the fructifications may appear double, triple, or even more complex. Conidia globose, 2.4 to $3\ \mu$ or $3.5\ \mu$, green, slightly granular. * †

CULTURAL DATA

Czapek.—Colonies dense, velvety, spreading, moderate elevation, white soon becoming bluish green with white margin. Growth very rapid. Spore production abundant. Reverse yellow to brown and wrinkled on edges.

Peptone.—Colonies very small, only slightly elevated. Growth slow and poor. Reverse brown, otherwise same as on Czapek.

Malt.—Colonies same as on Czapek.

Starch.—Reverse colorless, otherwise same as on peptone.

Potato.—Growth rapid. Reverse colorless, otherwise same as on peptone.

Gelatin.—Reverse colorless and smooth. Medium colored, otherwise same as on Czapek. Rapid liquefaction.

Maltose.—Growth slow. Reverse white then bright lemon yellow, otherwise same as on Czapek.

Mannose.—Colonies same as on maltose.

Inulin.—Colonies same as on maltose.

Levulose.—Colonies same as on maltose.

Dextrose.—Colonies same as on maltose, except that reverse is white and growth is rapid.

Penicillium chrysogenum Thom

Conidiophores arise separately, up to 300 μ long; some as short branches of aerial hyphae. Conidial fructifications 100 to 200 μ long with one or two alternate, divergent branches; usually in two stages, but may also have three; phialides 8 by 2.5 μ . Conidia elliptical, becoming globose, 3 to 4 μ , pale green.

CULTURAL DATA

Czapek.—Colonies round, broadly spreading, moderately elevated, densely floccose, white at first and soon becoming grayish green with white margin. Growth rapid. Spore production good. Reverse yellow.

Peptone.—Colonies loosely floccose. Growth slow and poor. Spore production poor. Reverse colorless, otherwise same as on Czapek.

Malt.—Colonies same as on Czapek, except that reverse is dark yellow to orange and wrinkled.

Starch.—Colonies very small, scattered, flat, dense, otherwise same as on peptone.

Potato.—Colonies same as on malt.

Gelatin.—Colonies same as on peptone. Slow liquefaction.

Maltose.—Colonies same as on Czapek.

Mannose.—Colonies same as on Czapek.

Inulin.—Colonies have a tinge of blue and not as much green. Reverse white to yellow, otherwise same as on peptone.

Levulose.—Growth very rapid. Reverse yellow to light green, otherwise same as on Czapek.

Dextrose.—Colonies same as on peptone, except that reverse is light yellow.

Penicillium digitatum Saccardo

Conidiophores arise directly from the substratum 30 to 100 μ by 4 to 5 μ , usually very short. Conidial fructifications a few tangled conidial chains up to 160 μ in length, in two stages; phialides 13 to 16 μ by 3 to 4 μ . Conidia cylindrical to almost globose, 4 to 7 μ by 6 to 8 μ , often uneven in size and shape in the same chain.

CULTURAL DATA

Czapek.—Colonies very dense, irregular, elevated, white at first and slowly becoming grayish olive. Growth rapid. Spore production slow and not abundant. Reverse brown to dark brown.

Peptone.—Growth not very rapid. Reverse white to yellow, otherwise same as on Czapek.

Malt.—Few if any spores produced in 4 to 6 day-old cultures. Reverse reddish orange, otherwise same as on Czapek.

Starch.—Colonies small and scattered. Reverse colorless, otherwise same as on peptone.

Potato.—Colonies same as on malt, except that reverse is brown and smooth.

Gelatin.—Colonies same as on peptone. Slow liquefaction.

Maltose.—Colonies delicate blue. Reverse white at first later becoming brown, otherwise same as on Czapek.

Mannose.—Colonies same as on Czapek, except that reverse is yellow and growth is slow.

Inulin.—Colonies same as on Czapek.

Levulose.—Reverse yellow to brown. Colonies zonate, otherwise same as on Czapek.

Dextrose.—Reverse yellow to green. Colonies zonate, otherwise same as on Czapek.

Sporotrichum pruinosum Gilman & Abbott

Aërial hyphae branched, hyaline, often roughened from which the conidiophores arise as branches; sterile hyphae often roped up to $10\ \mu$ thick. Conidiophores freely branched, oppositely or irregularly up to $25\ \mu$ long, bearing terminal conidia, oval or lemon-shaped, 9.5 to $13.5\ \mu$ by 6 to $10\ \mu$; appearing grayish.

CULTURAL DATA

Czapek.—Hyphae creeping, very prostrate, white, slowly spreading. Growth very scant. Spore production poor. Reverse colorless.

Peptone.—Colonies same as on Czapek, except that growth is slower and they are denser. No spores are produced on this medium.

Malt.—Colonies same as on Czapek, except that they are densely floccose, slightly elevated and spore production sparse or lacking.

Starch.—Colonies same as on Czapek, except that growth is rapid.

Potato.—Colonies same as on starch.

Gelatin.—Colonies same as on Czapek. No liquefaction.

Maltose.—Colonies same as on malt.

Mannose.—Colonies same as on starch, except that spore production is very abundant.

Inulin.—Colonies same as on malt.

Levulose.—Colonies same as on mannose.

Dextrose.—Colonies same as on malt.

Trichothecium roseum Link (4, 5)

Conidiophores erect, simple, compact, and continuous. Conidia oblong-obovoid, 2-celled, slightly constricted at the septum, rose colored, formed in heads at the end of the conidiophores, $16\ \mu$ in length by 8 to $14\ \mu$ in width.

According to Gilman and Abbott (6) *Cephalothecium roseum* Corda is considered the same as *Trichothecium roseum* Link. Their terminology is followed in this instance.

CULTURAL DATA

Czapek.—Colonies somewhat spreading, white at first later turning pink, flat, round, floccose, consisting almost entirely of conidiophores. Growth suppressed. Spore production very abundant. Reverse colorless to pale pink.

Peptone.—Colonies same as on Czapek.

Malt.—Colonies same as on Czapek, except that growth is more rapid and spore production much more abundant.

Starch.—Colonies same as on Czapek.

Potato.—Colonies same as on Czapek.

Gelatin.—Colonies same as on malt. Liquefaction.

Maltose.—Colonies same as on Czapek.

Mannose.—Colonies same as on Czapek, except that they are small and turn pink very much sooner.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on Czapek.

Dextrose.—Colonies same as on Czapek.

Hormodendrum cladosporioides (Fresenius) Saccardo

Conidiophores erect, branched, 100 to 200 μ long, olivaceous, toward the apex gradually alternate, ultimate branching copiously dividing with predominant tendency to dichotomy, septate, articulate above; conidia cylindrical to broadly oval, olivaceous, smooth, 3 to 6 μ by 2.5 to 3.6 μ , continuous or inferior ones rarely septate.

CULTURAL DATA

Czapek.—Colonies orbicular, dense, flat, spreading, with narrow margin, at first grayish, becoming olivaceous green. Growth rapid. Spore production very abundant. Reverse black.

Peptone.—Colonies same as on Czapek, except that color changes to grayish green, growth is slower and reverse is greenish black.

Malt.—Colonies same as on peptone, except that center is elevated, growth is rapid and reverse is black and wrinkled.

Starch.—Colonies same as on malt, except that reverse is not wrinkled.

Potato.—Colonies same as on starch.

Gelatin.—Colonies same as on starch. Rapid liquefaction.

Maltose.—Colonies same as on Czapek.

Mannose.—Colonies same as on Czapek.

Inulin.—Colonies same as on Czapek.

Levulose.—Colonies same as on Czapek, except that reverse is darker and has concentric rings. Growth is very slow.

Dextrose.—Colonies same as on Czapek.

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NOTES AND BRIEF ARTICLES

In order to meet the increase in demand for space in MYCOLOGIA the question of raising the price to five dollars (\$5.00) per year and the size proportionately is being seriously considered. Since MYCOLOGIA is self-supporting and the Editor would like to keep it so, expressions of opinion from subscribers as to the advisability of this move would be appreciated. It should also be mentioned that every additional subscription means a potential increase in the size of the publication.

Mr. Carlos E. Chardon, Commissioner of Agriculture and Labor of Porto Rico, and Mr. Rafael A. Toro, Plant Pathologist of the Department of Horticulture of Colombia, spent some time at the Garden during the month of May working over their collections of South American Fungi, preparatory to the publication of a check list of the fungi of Colombia.

Professor H. H. Whetzel of Cornell University sailed during the spring for Europe where he will spend several months studying European collections of the Sclerotinieae. He has already contributed much to our knowledge of the life histories of the various species of this tribe and expects within the next few years to complete a monograph of this section of the cup-fungi.

Mr. Robert Hagelstein of Mineola, Long Island, has recently been appointed Honorary Curator of the Myxomycetes of The New York Botanical Garden. Mr. Hagelstein has devoted much time to the study of the diatoms and myxomycetes and has one of the largest private collections of the latter to be found in the East. He will spend some time at the Museum Building arranging and studying the Garden collection of slime-moulds.

In MYCOLOGIA 22: 159 there appeared a note on the occurrence of *Peronospora valerianellae* Fuckel. in Arkansas. Prof. J. H. Miller sends a specimen on *Valerianella radiata* collected by him at Athens, Georgia, May 5, 1926. The local station is given as "Hort. Farm," which might lead one to suspect that it may have been introduced, but the Arkansas stations did not suggest that it was not indigenous.—J. J. DAVIS.

Professor Donald Reddick of Cornell University spent May 1st at the Garden examining herbarium specimens of species of *Solanum* and related forms. He has just come from the University of Vermont where he was consulting with Professor Lutman and others. He has recently been delegated by the United States Department of Agriculture to make a survey in Mexico endeavoring to find wild species of potatoes which may be immune to late blight, *Phytophthora infestans*.

The Editor wishes hereby to inform the readers of MYCOLOGIA that nearly half the edition of The North American Cup-fungi (Operculates) has been disposed of. There are many colleges which are offering courses in general botany and mycology which have not yet secured a copy of this work. Since this is the only monograph of this group of plants in America they should avail themselves of this opportunity before the edition is exhausted. A complementary volume on Inoperculates is in course of preparation, but it will necessarily be several years before this can be completed.

Dr. David Miller of the Cawthorn Institution, New Zealand, called on members of the Garden staff, May 2d. Dr. Miller is engaged by the New Zealand Government to make a survey of insects and fungus diseases of *Rubus fruticosus* and other weeds with the hope of finding certain parasites which would be sufficiently destructive to warrant introduction into that country. He was much interested in the three strains of the *Gymnoconia* orange-rust of blackberries as this seems to be the one parasite most destructive to species of blackberry.

PUCCINIA CARICIS-STRICTAE

Puccinia Caricis-strictae Diet. (Syn.: *Uromyces Caricis* Peck, *Dicaeoma Caricis-strictae* Arth. & Kern) is a peculiar and interesting rust whose aecium is not yet identified. In January Mr. Roy Latham sent me a packet of Long Island, N. Y., collections made during 1929. It included a *Boehmeria* leaf which bore a single aecium in good form. He remembered the identical spot of the collection and on request kindly made a return trip of over 25 miles to the place to seek rusted *Carex* leaves. He found what proved to be *Puccinia Caricis-strictae*. I did not get *Boehmeria* in time this spring to infect it with telial sporidiola but probably some readers of this note may have opportunity this season to make observations or experiments confirming or correcting the suspected connection stated above.—JOHN DEARNESS.



SEPULTARIA AURANTIA
SEPULTARIA ARENICOLA

MYCOLOGIA

VOL. XXII SEPTEMBER-OCTOBER, 1930 No. 5

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XIII. SUBHYPOGEOUS FORMS ¹

FRED J. SEAVER

(WITH PLATES 22 AND 23)

There are a number of species of cup-fungi which during their early stages are submerged or nearly so in the humus or sand in which they grow. For the most part these species are placed in one of two genera *Sepultaria* and *Sarcosphaera*. The former genus is distinguished by the growth of long dark colored hairs on the outside of the apothecia in which character they resemble the plants of the genus *Patella*. The plants of the latter genus are devoid of hairs and in this character resemble those of the genus *Peziza*. Five species of *Sepultaria* are recognized in North American Cup-fungi, one of which is illustrated (PLATE 13). Of the five species, three are characterized by having a whitish or creamy-white hymenium while in the other two the hymenium is orange or yellow.

SEPULTARIA AURANTIA

During the past summer while collecting with Mr. Shope of the University of Colorado, a large quantity of plants belonging to the genus *Sepultaria* and having the orange colored hymenium were collected. These were referred to *Sepultaria aurantia* Clements which was described from material collected in Nebraska. Our plants agreed well with his description but later comparison with a fragment supposed to be a part of the type of

¹ This paper is supplementary to The North American Cup-fungi (Operculates) which was published by the author and issued December, 1928.

[MYCOLOGIA for July-August (22: 163-213) was issued July 1, 1930]

Clement's species showed the spores in the Colorado specimens considerably larger. However, in view of the fact that the spores of these plants conform fairly well with his description it is possible that the material might have been mixed and we for the present refer our Colorado plants to the name assigned by Clements and publish at this time an excellent photograph made by Mr. Shope. These plants are at first entirely submerged but gradually emerge as they mature. The hymenium is yellow but becomes decidedly orange as the plants are dried out.

SEPULTARIA ARENICOLA

Recently an excellent photograph of *Sepultaria arenicola* was sent to the writer by Mr. S. C. Edwards of Colton, California. Since this species was not illustrated in North American Cup-fungi we reproduce it, with Mr. Edwards' permission, at this time. As will be noted the margins of the cups are sometimes entire and in other cases they split like the peridium of a *Geaster*. The hymenium in this species is creamy-white.

SARCOSPHAERA FUNERATA

Several years ago Mr. H. C. Beardslee sent the writer a collection of cup-fungi obtained by him in Florida and growing immersed in the sand. The species was not identified at the time and was overlooked so that no record of it appeared in North American Cup-fungi. Recently, however, the author has identified the species as *Peziza funerata* Cooke and the description and synonymy is appended as follows:

***Sarcosphaera funerata* (Cooke) Seaver, comb nov.**

Peziza funerata Cooke, *Grevillea* 6: 142. 1878.

Apothecia scattered, at first entirely immersed in the sand, appearing as holes in the ground with the irregular or slightly star-shaped margin appearing above the surface of the sandy soil, reaching a diameter of 2-3 cm., externally pitted from the adhering particles of sand; hymenium exposed at maturity, dull umber-brown; asci cylindric with an abrupt base, reaching a length of 275 μ and a diameter of 12-14 μ ; spores ellipsoid smooth 8-9 \times 16-18; paraphyses slender slightly enlarged above, clinging together and not very distinct, brown.

In sandy soil.

TYPE LOCALITY: Florida.

DISTRIBUTION: Florida and Michigan; also in Australia?

ILLUSTRATIONS: Cooke, *Mycographia* pl. 107, f. 380.

The following field notes were supplied by the collector: "The plant grows in the bare sand in cultivated orange groves. It is immersed in the sand and only the irregularly star-shaped opening shows. The shape is roughly globose with the mouth constricted and somewhat star-shaped. Apparently it is at first closed and the mouth opens as it develops, as the interior is entirely free from sand unless it is washed in by rain. The color is dull umber throughout. When they are appearing you will see in the grove, here and there, the irregular opening of the mouth in the white sand. I have found them in January and February here in New Surryma.

A few small specimens of this species were also sent to the writer by Dr. Edwin E. Honey from Albion, Michigan, growing on sandy soil. Also one specimen from Melbourne, Australia, was obtained from the collection of the late C. G. Lloyd which seems to conform with the species giving it rather a wide distribution although it has been but seldom collected.

SARCOSPHERA CORONARIA

The accompanying photographs of *Sarcosphaera coronaria* (Jacq.) Schröt., were made from material collected by S. H. Burnham in Washington County, New York. This species is characterized by its delicately violet-colored hymenium. It is a large species of partially submerged *Peziza* and frequently collected and illustrated in Europe, although only few collections from this country have been seen.

THE NEW YORK BOTANICAL GARDEN

EXPLANATION OF PLATES

PLATE 22

Upper figure. *Sepultaria aurantia*. Photograph of a cluster of apothecia at various stages of development, about natural size. Photograph by Mr. Paul F. Shope. Left, drawing of a portion of an ascus with spores and the tip of a paraphysis. Right, drawing of one of the hairs from the outside of an apothecia.

Lower figure. *Sepultaria arenicola*. Photograph of a cluster of apothecia

at various stages of development. Photograph by Mr. S. C. Edwards of Colton, California. Left, drawing of a portion of a hair of an apothecium. Right, tip of an ascus with spores.

PLATE 23

Upper figure. *Sarcosphaera funerata*. Photograph of three apothecia about natural size. Photograph by H. C. Beardslee of Perry, Ohio. Left, drawing of an ascus with spores and a portion of a paraphysis. Right, diagram of an apothecium showing habitat submerged in sand.

Lower figure. *Sarcosphaera coronaria*. Photograph of a cluster of apothecia made from material sent by S. H. Burnham from Washington County, New York. Right, drawing of an ascus with spores and a portion of a paraphysis.



SARCOSPHERA FUNERATA
SARCOSPHERA CORONARIA

A NEW CHANTERELLE IN CALIFORNIA

ELIZABETH EATON MORSE

(WITH PLATES 24 AND 25)

***Cantharellus Bonarii* sp. nov.**

Pilei 3-7 cm. broad, fleshy, involute at first, regular in young plant, spreading and undulate at maturity, depressed at center; surface broken into thick, floccose more or less erect scales which fill the central depression. Scales orange colored at tips blending to lemon yellow at base, giving entire cap an orange-yellow color. Flesh white, firm, tapering in thickness to the margin.

Gills thick, very narrow, meruloid, decurrent, in some cases extending downward to half the length of the stipe, usually less, milk white in color, subdistant.

Stipe white, somewhat earth-stained, stout, solid, glabrous, 10-15 mm. in thickness, dilated upward into the pileus, mostly fused with other stipes from a common base, producing up to thirteen sporophores in one cluster—whole group 5-7 cm. tall.

Spores elliptic, hyaline, smooth, apiculate, 10-12 (14) \times 5-6 microns.

Basidia 20-30 \times 7-8 microns, 4-spored.

Odor none, not tested for taste.

Closely gregarious, partially hidden in deep humus under pine and fir. Type collected in two localities in General Grant National Park, California, September, 1927, by N. Nielsen and F. Mitchell.

The most striking feature of these collections is that the majority of the plants develop in gregarious clumps from fused bases, with occasional solitary specimens.

The surface of the pileus suggests very strongly *Cantharellus floccosus* Schw., but the depression in the pileus in our species is slight, while that in *C. floccosus* extends far into the base of the stipe; the stipe in the young plants consists of solid tissue throughout. The gills of our species are white and do not extend as far down toward the base as in *C. floccosus*. Spore measurements, however, do not differ much from those given by different

authors for *C. floccosus*. Specimens of this plant have not been found since the first season.

I wish to acknowledge the assistance of Doctor Lee Bonar in my study of this plant, also that of Doctor C. H. Kauffman for his review of this paper.

UNIVERSITY OF CALIFORNIA,
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CANTHARELLUS BONARII



CANTHARELLUS BONARII

TRAMETES HISPIDA A DESTRUCTIVE PARASITE IN APPLE ORCHARDS

ERNEST C. SMITH

(WITH PLATE 26)

Trametes hispida Bagl., the American form of which has become familiar under the name of *Trametes Peckii* Kalchbrenner, has commonly been regarded as a saprophyte occurring only on the dead wood of willows and poplars. Observations extending over a period of six years have demonstrated that in Eastern Colorado this fungus is frequently found on apple trees and that on the new host it functions primarily as a parasite, the attacks in many cases proving fatal to the trees.

Murrill,¹ Overholts,² Saccardo³ and Seymour⁴ in their published works agree in restricting the occurrence of the American form to members of the Salicaceae; but in a letter Prof. Overholts calls attention to a collection from *Pyrus* at Bozeman, Montana, by Swingle in 1911 and to one by Long in the same year from the pepper-tree, *Schinus molle*, at Los Angeles. Saccardo⁵ lists *T. hispida* as occurring on the dead wood of *Quercus*, *Fagus* and *Salix* in Italy and on the trunks of *Ceratonia* in Algeria, possibly implying a parasitic character on this last-named substratum.

In the writer's experience this fungus for some time was observed only as a saprophyte on stumps of cottonwoods at Greeley, Colorado. Later it was found in the mountains at moderate elevations, but still saprophytic on cottonwoods. Doubts as to the limitation of hosts and the exclusively saprophytic habit were roused at the same time by the discovery of well-developed pilei of this fungus on a living apricot tree. However, other fungi were present, the heart-wood of the tree was

¹ N. Am. Flora 9: 79.

² The Polyporaceae of the Middle Western U. S. p. 69.

³ Syll. Fung. 6: 341.

⁴ Host Index of the Fungi of N. Am. pp. 188, 190, 191, 192, 193, 194.

⁵ Syll. Fung. 6: 346.

decayed, and the parasitic character was suspected, rather than demonstrated.

The demonstration was provided later in connection with more extended observations at Fort Collins. The fungus was observed on a living and otherwise healthy cottonwood and watched from the first appearance of the sporophore to its maturity. The brackets were very numerous in an apple orchard about a mile south of Fort Collins, being most noticeable on dead and dying trunks. Investigations extending over a period of three years proved that these represented a final stage and that the initial appearance, easily overlooked, was on living twigs and young branches. As these died and were pruned away the mycelium made its way to the base of the branch and finally to the trunk, its progress from season to season being marked by the appearance of pilei farther down on the branch or trunk. The general indications were those of a typical heart-rot. Some forty trees had been killed, many were distinctly weakened and a considerable number showed the initial infection. No other significant fungi were found in the orchard. While the growth of the mycelium within, and of the pilei upon the dead trunks continued, there is no doubt that the fungus worked primarily as a parasite and only later as a saprophyte.

His attention once called to these facts, Dr. L. W. Durrell noticed and reported similar conditions in apple orchards near Canon City. ,

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EXPLANATION OF PLATE 26

Pilei of *Trametes hispida* Bagl., showing position on trunk of living apple tree and lower and upper surfaces of other pilei from the same host.



TRAMETES HISPIDA

A NEW TRUFFLE IN BEDS OF CULTIVATED MUSHROOMS

W. W. DIEHL AND E. B. LAMBERT

(WITH PLATE 27)

† The occurrence of an unknown fungous pest in mushroom beds was first called to our attention in May, 1929, by a commercial mushroom grower at Ashtabula, Ohio. The complaint was made that it was "filling his beds and completely stopping the production of mushrooms." Specimens of soil and manure were submitted which contained ascocarps of an undescribed truffle. The infested mushroom houses at Ashtabula were visited early in June to obtain fresh material of the fungus and to make first-hand observations of its growth habits and the damage caused. Later, similar infestations were observed at Minneapolis, Minnesota, and in several mushroom houses in Chester County, Pennsylvania. Specimens which proved to be the same species have also been received from Rosendale, New York. Although its spores are smaller than those of any known truffle the structure of the fungus indicates its affinities to be among the Tuberales, apparently most closely related to *Pseudobalsamia*¹ Fischer or to *Balsamia* Vitt. Since it is quite different in certain respects from known species of these genera it seems proper to describe it as a new species.

***Pseudobalsamia microspora* sp. nov.**

(PLATE 27, FIGURES A-H)

Ascocarps cream-colored to reddish brown, subspherical to discoid, irregularly lobed, 0.5–3.0 c. in diameter infolded at a distinct base when formed on the surface of the substratum; surface convolute to cerebriform; context fleshy, of interwoven hyphae generally thick walled, outer cells disintegrating to form an indefinite cortex or false rind, surface minutely scabrous,

¹ The writers are sincerely grateful to Dr. Helen M. Gilkey for pertinent criticism of the taxonomic viewpoint expressed here.

interior composed of closely crowded venae internae (spore bearing folds) separated by venae externae (labyrinthine canals) filled with a loose web of anastomosing hyphae, canals converging at one or more points, usually having a common opening to the exterior, sometimes opening to the surface at more than one point; paraphyses reduced to anastomosing hyphae $5-7\ \mu$ in diameter; asci fugaceous, irregularly arranged throughout the venae internae, short or long stipitate, ovate to subspherical, (p. sp.) $18-25 \times 12-15\ \mu$ with 8 spores or less, irregularly arranged, stipe variable, $3-10\ \mu$ broad and $6-15\ \mu$ long; spores subspherical, hyaline, sulphur-colored in mass, $5-7\ \mu$, chiefly $6\ \mu$ in diameter, usually with one large colorless oil drop; epispore smooth, colorless, less than $1\ \mu$ thick; hyphae within the venae externae $8\ \mu$ to $12\ \mu$ in diameter; chlamydospores occasionally within hyphae of the ascocarp, spherical, $13\ \mu$ in diameter, content golden-brown with epispore $2\ \mu$ thick, smooth to finely granular.

HABITAT. Known only in mushroom beds; in the compost and on the surface of the soil.

GEOGRAPHIC DISTRIBUTION: Minnesota, New York, Pennsylvania, and Ohio, U. S. A.

SPECIMENS CITED: Ashtabula, Ohio, May 17, 1929, Dallas Luce; June 19, 1929, Dallas Luce and E. B. Lambert—Type; Minneapolis, Minn., July 14, 1929, E. B. Lambert; Rosendale, N. Y., Sept. 5, 1929, Hans Johanssen; Concordville, Pa., Sept. 25, 1929, F. J. Styer; Oct. 21, 1929, F. J. Styer and E. B. Lambert.

Specimens are deposited in the Mycological Collections, B. P. I., and certain duplicates in the Farlow Herbarium at Harvard University, the Herbarium of The New York Botanical Garden, and the Missouri Botanic Garden. Permanent slides deposited in Mycological Collections, B. P. I.

The fungus was isolated in Thaxter's potato agar by the tissue culture method and grown in pure culture upon neutral peat, and media made from different combinations of wheat, oats, rice, corn-meal, soil extract, and manure extract. Of these media, ascocarps developed best on boiled oats and soil extract (PLATE 27, FIG. C).

The ascocarps are variable in size, shape and color. They develop differently inside the bed than on the surface. Inside the bed they appear first as cottony wefts of mycelium from 1 mm. to 2 or 3 cm. in diameter. These wefts of mycelium

become more and more dense until they have assumed definite shape. In some cases several small ascocarps lying close to each other coalesce and form one larger ascocarp; they usually fill air pockets instead of expanding in tightly packed compost. On the surface of the beds there is often an extensive mycelial growth prior to ascocarp development, especially in a damp atmosphere. The mycelial growth over the surface of the bed may cover an area of a square meter about 1.5 cm. thick. From this loose web the ascocarps develop as flattened, cerebriform, discoid structures with an opening on the ventral surface adjacent to the soil. Ascocarps may develop from a rudiment to a fully formed structure in four or five days.

The maturation of the ascocarps, *i.e.*, the formation of asci and ascospores, apparently is not dependent upon the size of the ascocarp. Under certain conditions asci and spores are formed when the ascocarp is 1 mm. or less in diameter; under other conditions the ascocarp may reach a diameter of 3 cm. before spores are formed. Preliminary observations of the growth in mushroom beds and in pure culture indicate that the size of mature ascocarp is dependent on numerous factors such as size of the air cavities in the compost, nutritional conditions, moisture content of the compost, and relative humidity of the atmosphere. The asci disintegrate with the desiccation of the ascocarp and the ripening of the spores, leaving an olivaceous sulphur-colored dusty mass of spores and hyphal fragments. Because of this powdery texture it is quite difficult to determine the structure of the ascocarp when mature without recourse to the sectioning of material that has been imbedded in paraffin.

The fungus apparently belongs in the Balsamiaceae but differs in many respects from the usual concept of any genus in that family. The irregular arrangement of the asci in the venae internae and the frequent convergence of venae externae into a common opening suggest a close relationship with *Pseudobalsamia*. It therefore seems expedient to place the species here until more conclusive evidence of other relationships is established. The fungus may be indicative of an undescribed genus but it seems preferable to include it in a broadened concept of *Pseudobalsamia*.

Little is known regarding the relation of the fungus to the

mushroom mycelium in the beds. During the early stages of the crop the yield of mushrooms in infested beds is usually normal. Under certain conditions, however, it is evident that the truffle materially reduces the yield during the latter half of the crop. Circumstantial evidence suggests that it enters the mushroom house in the compost and acts as a fungous weed rather than as a parasite in the mushroom bed. Further observation and experiment with pure cultures are necessary to clear up these points.

BUREAU OF PLANT INDUSTRY,
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EXPLANATION OF PLATE 27

Fig. A. Surface view of an infested mushroom bed, showing flattened cerebriform growth over the casing soil. (Ashtabula, Ohio, June, 1929.)

Fig. B. Interior of an infested mushroom bed, $\times \frac{1}{4}$, showing numerous ascocarps. (Ashtabula, Ohio, June, 1929, Luce and Lambert.)

Fig. C. Ascocarps in pure culture on medium of oats and soil filtrate $\times 1$.

Fig. D. Flattened ascocarps from soil surface, $\times 1$. (Ashtabula, Ohio, June, 1929, Luce and Lambert.)

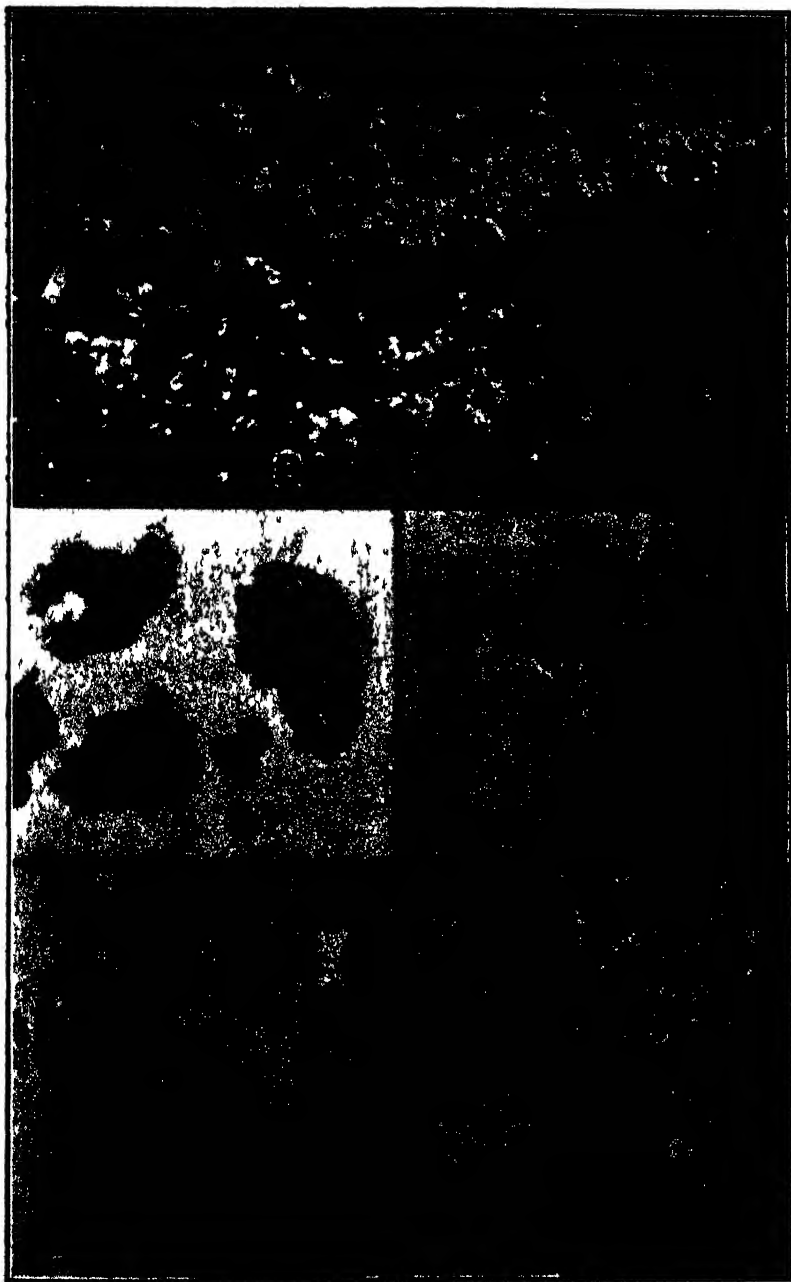
Fig. E. Ascocarps taken from the inside of a mushroom bed, showing their subspherical cerebriform shape. $\times 1$. (Minneapolis, Minnesota, June, 1929, Lambert.)

Fig. F. Section through an ascocarp, $\times 11$, showing the dense folded spore-bearing layers (venae internae) separated by sterile loose web hyphae (venae externae). (Ashtabula, Ohio, May, 1929, Luce.)

Fig. G. Detail of venae internae of Fig. F, showing immature spores in closely crowded asci. $\times 500$.

Fig. H. Mature asci showing irregularly arranged spores, $\times 950$. (Concordville, Pa., Oct., 1929, Styer and Lambert.)

(Photomicrographs by J. F. Brewer)



PSEUDOBALSAMIA MICROSPORA

SOY-BEAN STOVER COMPOST FOR MUSHROOM CULTURE

ILLO HEIN

In the search for substitutes for the horse manure still almost exclusively used in commercial practice, further crude practical tests with composted soy-bean stover have given encouraging results although the yields were considerably below those obtained in the wheat straw compost and the checks which consisted of horse manure, handled in the conventional manner of composting. I have earlier reviewed the data (1930) in the literature concerning straw compost and given an account of tests made with it in mushroom culture. The yield of mushrooms from straw compost showed that it has possibilities in commercial practice but before it can be generally recommended to the growers data concerning the economical treatment of the straw and means for obtaining improved productivity will be necessary. Lambert (1929) has recently announced the production of mushrooms from straw compost, but also states that his results to date are unlikely to give much satisfaction to the commercial growers. Since the announcement of the straw compost studies I have found that the admixture of a small amount of horse manure with the straw gave a very satisfactory product and yields slightly better than those first reported (1930).

Well cured soy-bean stover was stacked in compost heaps and thoroughly watered. The first trials were conducted indoors in a cellar under the head house of the botany greenhouses during the winter months and four heaps were made. The latter were built up in stacks approximately 6×6 , by 8 feet high to the ceiling. The comparatively high nitrogen content of the stover made it appear unnecessary to add further nitrogen compounds for the cellulose decomposing organisms yet in one stack horse manure was used.

Of the four compost heaps, lot number 1 was made entirely of the stover. Lot number 2 contained equal parts by volume of

wheat straw and soy-bean stover (the heap was built up with alternate 4-inch layers of each). In lot number 3, three parts by volume of straw was used to $\frac{2}{3}$ stover and in lot number 4 about $\frac{1}{3}$ part fresh horse manure was added.

The temperature rose slowly in the stover. In ten days the heaps attained a temperature around 80° F. In three weeks heap number 4 rose to 100° while the other three varied around 90° F. In four weeks a temperature of 120° was attained in heaps 2 and 3, while number 4 attained 130°.

At this time the lots, which had become reduced to about $\frac{1}{2}$ the original volume, were broken down, forked over, watered, and made up into new heaps. The temperature had dropped to almost room temperature, 70°, in all the heaps and rose very slowly after the first week following the forking over. Two weeks later the temperature rose to around 110 degrees and then there was a gradual falling off until in eight weeks the piles cooled down to 100°. By this time there were considerable changes in the stover, the leaves were very soggy, and the smaller twigs and branches soft but the stouter sticks remained rather hard. In nine weeks the heavier sticks became softly brittle. The mass was by this time very black, had a sweet smell and began to look like a good compost. The stouter sticks, however, were still too hard to permit satisfactory forking over. Another turning was made after eleven weeks. In twelve weeks the stover was well broken down and a rich looking black compost which, while it was a bit soggy from excess watering, was on the whole a "good looking" product.

From the composted product 14 small beds were made up. Six were made up in the experimental mushroom house (Hein, 1929), 4 in the cellar under the head house of the botany greenhouses, and 4 in the old farm cistern converted for mushroom growing.

The beds were in all three places constructed in the conventional shelf type manner but they were not of standard size. The beds were arranged in three tiers, each about 3 feet wide and 30 inches high, running the length of the cellars. The plots were partitioned off at 18 inch intervals and made up about 7 inches in depth. In the experimental house the temperature was maintained around 75° F., in the cistern around 60° F. and under the

headhouse around 70° F. The temperatures fluctuated within 5° but were on the whole fairly constant. Beds were then made up and inoculated with spawn grown from spores on agar media in the laboratory.

The spawn in the beds containing the straw made the best run at the start and tended to be less "stringy" than in the beds containing no straw.

No correlation between the different temperatures in the three plants and either productivity or run of the mycelium was shown on either soy-bean compost beds, straw compost, horse or cow manure beds.

In no case was a satisfactory production of mushrooms from the soy-bean stover compost beds obtained but some mushrooms appeared on all the beds. Check beds produced well so that presumably the environmental conditions in the houses were not responsible for the low yields. Of the total area the average harvest per square foot was around 4 ounces. In some patches good clusters of normal sporophores appeared and here it was found that the physical condition of the compost was more like that found in good horse manure beds. I am of the opinion that the physical condition of the compost may have had more to do with the low productivity than the possible available nutritional substances in the compost.

The best method of handling the stover still needs to be determined by further experiment.

The mycelium grew very slowly at first and made a rather "stringy" growth from the beginning. The slow growth was possibly due largely to the excess of water contained in the compost. Excessively moist compost is, as I have earlier shown (1930), a possible factor concerned with the production of "stringy" mycelium. The soy-bean stover when thoroughly rotted dries very slowly and if once watered too heavily is difficult to restore to an optimum content.

The partial success of the first trials made further tests appear worth while. Since the presence of horse manure had no noticeable effect on mycelial growth no further tests were made with it at this time. The straw added somewhat to the improvement of the physical condition of the product and may eventually prove

to be useful in the mixture. Where the straw was used there was less tendency to soggy pockets and thus it aided in the making of a more uniform product.

Further compost tests were carried on outdoors in the spring and summer months. Heaps were made up with varying percentages of wheat straw and well cured soy-bean stover.

Eight heaps were made up this time and aside from the varying mixtures with straw and more attention to watering to avoid excess the lots were treated in about the same manner as were the preliminary ones.

Only ten beds were made up this time and all were prepared in the experimental house. Since the trials were conducted during the warmer months considerable difficulty was experienced in maintaining sufficiently low temperatures. The temperature repeatedly rose to 85° and even 95° F. In spite of this a fair run of mycelium was obtained in most of the beds and normal sporophores developed to maturity on four of them. On the other beds there appeared a few clusters of buttons of which some attained about a centimeter in diameter and then died off. The beds on which mushrooms grew to maturity were not noticeably different from those in which the mushrooms died off. Possibly temperature and moisture tends to be nearer the optimum in the more productive beds and this was not determined accurately.

The productivity of the beds if we exclude those in which the mushrooms died off prematurely was somewhat below that of the previous trails but undoubtedly the high temperatures were largely responsible for the reduced yields.

The tests, while they do not offer much encouragement to the commercial grower, indicate possibilities in this material and it is hoped that this announcement may lead others to make further tests since it will, even with the treatments given, produce mushrooms.

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MYCOLOGICAL NOTES FOR 1928-1929 ¹

L. O. OVERHOLTS

(WITH PLATES 28-31)

1. *ALTERNARIA DIANTHI* Stevens & Hall.

Originally reported from North Carolina (Bot. Gaz. 47: 409-413. 1909), this species finds little mention in the literature. This year (September, 1929) it was brought in by Dr. R. S. Kirby from a greenhouse in Reading, Pa., where it was causing extensive damage. The stems were usually cankered on the lower half and soon died. The whitened lesion bore abundant conidiophores, short, erect and in tufts, so that under a lens they appeared like *Colletotrichum acervuli*. My measurements of the spores ($45-72 \times 12-19 \mu$) are somewhat shorter than those given by Stevens and Hall. At any rate the spores are narrower than in most *Alternaria* species, and therefore, rather characteristic. They are rather strongly constricted at the septa, the middle cells often bulging considerably.

2. *ASCOCHYTA CATALPAE* F. Tassi

A collection of leaves of *Catalpa* sent in from Newville, Cumberland County, Pa., on July 5, 1929, bore numerous spots typical of *Macrosporium Catalpae* Ellis & Mart. which was fruiting abundantly on some of the spots. Others were occupied by an *Ascochyta* which I take to be *A. Catalpae*, hitherto not reported from this country. Besides the small circular spots, large and irregular areas of the leaves were dead and on these the fungus was fruiting more abundantly. The following notes were made from this collection:

Pycnidia epiphyllous on small spots associated with *Macrosporium Catalpae* or on larger dead areas several centimeters in extent, not conspicuous, the spots grayish-brown with a

¹ Contribution from the Department of Botany, The Pennsylvania State College, No. 72. Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station, as Technical Paper No. 507.

darker border; pycnidia depressed-globose, the wall brown rather than black as seen in sections, about $100 \times 75 \mu$; conidiophores not seen, the pycnidia entirely filled with spores; spores elongate, hyaline, 2-celled, $11-13 \times 3-4 \mu$.

On living leaves of *Catalpa*, associated with *Macrosporium Catalpae* (Overholts Herb. no. 11663) (PLATE 29, FIG. 8).

It would appear that this fungus is not the primary cause of the spots, since they are typical of those formed by the *Macrosporium* which is fruiting abundantly on some of the smaller spots, but on many of the larger ones the *Ascochyta* occurs.

Dr. Dearness writes that this might be a 2-celled condition of the usual *Phyllosticta* on *Catalpa*.

3. CAMPTOUM CURVATUM (Kuntze) Link.

From a collection made near Clearfield, Pa., April 3, 1929, on dead *Carex* leaves, and identified by W. W. Diehl, the following diagnosis was drawn:

Fruiting stage appearing as small black cushion-shaped dots, $1/5$ mm. diameter; in section showing no sterile base, hence not a sporodochium, but composed entirely of cylindric conidiophores $40-60 \times 3-4.5 \mu$, which are hyaline except for the black and very prominent septa and the brownish, bulb-like cell at the base, the terminal cell narrow-conical and sporiferous, the sterigma extremely small and inconspicuous; spores produced in clusters on the terminal cell, very irregular in shape, ovoid to subglobose and always a considerable portion of them somewhat lunate, blackish-brown, smooth, 1-celled, $9-12 \times 6-7.5 \mu$.

Macroscopically this fruiting structure looks like a sporodochium such as is produced by *Strumella* or *Epicoccum*. But in section, the absence of sterile stromatic tissue probably gives sufficient grounds for referring it to the Dematiaceae rather than to the Tuberculariaceae. Winter describes and illustrates this species in Rabenhorst, but gives spore measurements of $18-20 \times 7-8 \mu$. In most other points his description is so applicable that an error in measurements might be postulated. I have had no authentic material for comparison (Overholts Herb. no. 11521) (PLATE 29, FIGS. 9, 12).

4. HARKNESSIA CAUDATA Ellis & Ev.

Collected on small branches of fallen *Quercus* in Huntingdon Co., Pa., May 30, 1928. The species is well described in the

original article. It appears as small erumpent pustules on the bark, very inconspicuous until the spores are being discharged. Spores elliptic or fusoid, olivaceous-brown, 1-celled, $18-23 \times 6-8 \mu$, with the base tailed with the conidiophore, the tip attenuate into a hyaline, narrow, straight or curved appendage, $15-20 \mu$ long (Overholts Herb. no. 11030) (PLATE 29, FIGS. 7, 11).

5. PHOMA OLERACEA var. ANTIRRHINI Sacc.

Specimens of *Antirrhinum majus* suffering from a serious canker disease on the lower parts of the stems, were sent in from Upper Darby, Pa., in November, 1929. Dr. H. W. Thurston and the writer investigated the fungus concerned and arrived at the conclusion that it is referable to the above species as described by Saccardo. Its relation to the cabbage fungus was not investigated. The following notes were made:

Pycnidia cortical and erumpent, black, numerous, in section compressed-globose or globose, with a definite wall, $100-125 \mu$ diameter; conidiophores short and quite inconspicuous; conidia oblong or oblong-elliptic, not constricted, hyaline, 1-celled, $4-6 \times 2-2.5 \mu$.

Forming conspicuous cankers on the stem near the ground line, these soon blackish in color (Overholts Herb. no. 11882).

6. PHYLLOSTICTA BALDENSIS Massal.

This was collected at State College, on *Paeonia officinalis*, after the plants had been killed by frost in December. Spores minute, bacilliform, $3.5-5 \times 0.75 \mu$. I have seen no previous report of this species from America. Dr. Dearness verified this reference of the fungus and sent me a piece of a leaf of *Paeonia* from Massalonga's collection and identification. *P. Commonsii* Ellis & Ev. would seem to be distinct in the very different spores, $4-8 \times 2-2.5 \mu$ (Overholts Herb. no. 11492).

7. SCOLECOTRICHUM CLAVARIARUM (Desm.) Sacc.

On July 1, 1928, plants were collected of *Clavaria cristata*, showing a smoky black coloration at the base of the stem or involving almost the entire plant, giving in this case the semblance of the conidial stage of a *Xylaria*. When this was examined

microscopically the coloration was seen to be due to an imperfect fungus, apparently parasitic on the *Clavaria*, producing brown 2-celled conidia, $15-18 \times 5-6 \mu$. These measurements are somewhat smaller than those given in Rabenhorst but there seems to be no doubt of the identity of the parasite which is said to be the conidial stage of *Rosellinia Clavariae* (Tul.) Winter (Overholts Herb. no. 11084).

8. CALICIOPSIS PINEA Peck*

Fitzpatrick (Mycologia 12: 225. 1920) describes and discusses this and other species of *Caliciopsis* in his monograph of the genus. He reports it as occurring only on pines in this country. In Pennsylvania it is very common on the bark of small trees of living *Pinus Strobus*, sometimes associated with the small brown circular depressed cankers mentioned by Fitzpatrick and sometimes on a more conspicuous type of canker. The cankers of the latter type bear resemblance to the extreme roughening of the bark caused by the pine woolly aphis, occurring in most pronounced form just below the branch whorls. Small saplings heavily infested with this injury have been noted to die where at times, at least, no other agency responsible for their death could be found, so that I am inclined to agree with Fitzpatrick's guarded statement that the fungus is parasitic.

On May 30, 1928, this fungus was collected near Charter Oak, Huntingdon County, Pa., on a small dead sapling of *Tsuga canadensis*. This is the first report, apparently, of its occurrence on this host. Only a very limited amount of material was taken in this collection, but the fungus was in fine ascus fruiting condition.

9. HYPOCREA GELATINOSA (Tode) Fries.

Collected at Musser Gap, Center Co., Pa., Oct. 22, 1928, on dead limbs of *Carpinus caroliniana*. This is the first record of the species in my Pennsylvania collections. The two cells of the greenish to brown spores remain in contact until quite mature, separating eventually and then globose-oblong in shape, $5-6 \times 4 \mu$. The description in Ellis and Everhart's *Pyrenomycetes* is quite applicable (Overholts Herb. no. 11437).

10. *MOLLISIA PINASTRI* (Cooke & Peck) Sacc.

Originally described by Peck (Buf. Soc. Nat. Sci. Bull. 2: 297. 1875) as *Penisa pinastri*, and again (Grevillea 7: 40. 1878) as *Cenangium acuum* Cooke & Peck. Collected in quantity on dead needles of *Pinus Strobus* on small trees felled about a year previously, at Mont Alto, Franklin Co., Pa., May 31, 1929. Evidently entirely saprophytic. The small dark apothecia are less than 1 mm. diameter, and occur singly and scattered on the dead needles. Spores narrow fusoid, hyaline, $10-14 \times 4 \mu$; paraphyses distinctly colored at the tip and $4-6 \mu$ diameter (Overholts Herb. no. 11704) (PLATE 31, FIG. 21).

11. *OTTHIELLA STAPHYLINA* (Ellis & Ev.) Dearn. & House.

Originally described as occurring on *Staphylea trifolia* and reported on that host by Dearness and House from Peck's collections (N. Y. State Mus. Bull. 266: 71. 1925). Collected at State College, Pa., in 1928, on *Staphylea pinnata*. Dearness and House report the spores as hyaline and transfer the species from *Othia* to *Othiella* on that basis. The spores of my collection are recorded as faintly colored, and measure $10-15 \times 4-6 \mu$. The gross features of the fruiting stage are shown in PLATE 31, FIG. 20 (Overholts Herb. no. 11436).

12. *RHYTISMA PUNCTATA* (Pers.) Fries.

This species is common in the eastern United States. The usual hosts are *Acer pennsylvanicum* and *A. spicatum* and in central Pennsylvania it is rarely found on other hosts. Very occasionally it is present on *A. saccharum*. In the summer of 1924 it was collected on *Acer negundo* at Scott, Quebec, in considerable abundance. I have seen but one other previous record of it on this host (see Pl. Dis. Rept. Suppl. 37: 370. 1925). *Acer negundo* is given in Seymour's Index as host for both this species and *R. acerina* (Overholts Herb. no. 12027).

13. *TAPESIA ROSAE* (Pers.) Fuckel.

In clearing out dead wood from a large cultivated rose bush on the College Campus in July, 1928, a small *Cenangium*-like fungus was found on some old dead stalks. The apothecia were about 1 mm. diameter, sessile, grayish white and with a white fibrillose rim. One piece of the bark bore a distinct dark brown subiculum

from which the apothecia arose but most of the collection showed no subiculum at all under a hand lens. After failing to determine its identity with certainty, specimens were sent to Miss Edith K. Cash of the Washington Office of Mycology, who determined it as the above. A comparison of the descriptions of *Tapesia Rosae* and of *Mollisia cinerea*, shows little beside the brown subiculum to separate the two species, yet while I have been familiar with *M. cinerea* for years, I did not think of it in connection with this specimen. The following "description" was written from the specimens at hand:

Apothecia on the bark, probably not distinctly erumpent, sessile, gregarious, seated on a brown subiculum or subiculum definitely none, about 1 mm. diameter, the hymenium grayish-white, becoming slightly yellowish or bay on drying, the margin finely white-fibrillose, externally dark colored; in section showing a black exciple with a hyaline hypothecium of about equal thickness; asci $45-60 \times 4-6 \mu$, 8-spored; spores biseriate, elongate, hyaline, 1-celled, $7-10 \times 2-2.5 \mu$; paraphyses filiform, simple, about 2μ diameter at the apex.

On the dead bark of dead rose stems (Overholts Herb. no. 11108).

14. TYMPANIS ALNEA (Pers.) Fries.

Bursting through the bark in the form of small globular masses of apothecia, 5-20 apothecia per cluster, the clusters up to 4×2.5 mm., the apothecia about 0.5 mm. diameter, with a definite narrow stipe-like attenuation below, black without and within; asci clavate or subcylindric, about $150 \times 15 \mu$, filled with countless allantoid, spermatoid or bacilliform spores, $3-3.5 \times 1 \mu$; paraphyses filiform, about 2μ diameter, not much branched and not much enlarged at the apex, the tips brownish and there agglutinated loosely to form a slight epithecium in which the individual paraphyses are yet discernible and from which they separate readily.

On dead standing *Alnus*. Stone Creek, Huntingdon Co., Pa. April 16, 1928 (Overholts Herb. no. 10960) (PLATE 29, FIGS. 10, 13).

The plants described above differ from the descriptions available only in that the paraphyses are described as 6μ diameter (hence much enlarged) at the apices. In my plants they are scarcely enlarged upwards. *T. conspersa* is also reported on *Alnus* and the description agrees about as well.

15. *Corticium effusum* sp. nov.

Rather widely effused for several centimeters, adnate, thin, sub-fleshy, "tilleul buff" or "pale pinkish buff" (Ridgway) on drying, not cracked, somewhat granulose, the margin thin, determinate; in section 200–250 μ thick, homogenous, the subhymenium rather compact of suberect hyphae only about 2 μ diameter between very numerous vesicular pyriform bodies 15–20 \times 12–15 μ , thin walled; spores oblong or oblong-ellipsoid, smooth, hyaline, 4–5 \times 2.5–3 μ ; cystidia none; gloeocystidia rather numerous in the basidial layer, sub-cylindric, 24–40 \times 6–8 μ , with a dense colored content, soon becoming very inconspicuous in KOH mounts and less rapidly so in lactic acid.

On wood of *Acer*. Type collected on ten year old *Acer* slash at Ferdinand, Vt., Oct. 1, 1926, by Dr. P. Spaulding (no. 43963) (Overholts Herb. no. 11324) (PLATE 28, FIG. 2).

The coloration of this species is quite similar to that of *Peniophora pubera*, but in other characters it has no similarity. It should be easily recognized by the multitude of small vesicular bodies in the subhymenium and the gloeocystidia in the hymenium. It would seem to fall near *C. vesiculosum* Burt, particularly in the somewhat similar coloration, the small diameter of the subhymenial hyphae, and the presence of vesicular bodies and gloeocystidia, the former, however, only 5–7 μ in diameter in that species. It differs further in not being at all stratose. The appearance of the vesicular bodies in sections is almost identical with that of *Stereum Murrayi* Berk. & Curt.

16. *Peniophora piceina* sp. nov.

Fructifications effused in small orbicular or irregular patches 1–4 cm. diameter, thin, adnate, the hymenium very pale drab or gray, "ivory yellow" or "pale olive buff" (Ridgway), more or less granular, becoming much cracked into very small four-sided areas but not revealing the underlying white subiculum, the margin determinate; in section 60–100 μ thick, homogenous, of very compactly interwoven hyphae; spores ellipsoid, smooth, hyaline 4–5 \times 2.5–3 μ ; cystidia quite inconspicuous except in very thin sections, confined to the basidial layer, broadly short clavate or ob-pyriform with a small rounded bead at the apex, the whole 18–20 μ long, 6–8 μ diameter, scarcely projecting beyond the basidia, not incrusting, hyaline.

On bark of limbs of *Picea rubens*. Type collected at Cherry

Mt., N. H., July 7, 1926, by Dr. P. Spaulding (no. 43890) (Overholts Herb. no. 11263) (PLATE 28, FIG. 3).

I find no species of *Peniophora* described with the peculiar cystidia of this collection. Due to the fact that they do not project beyond the basidia, the small rounded bead at their apex might easily be mistaken for a globose spore on a basidium.

The general appearance of the species is similar to *P. album* Atk. & Burt from which this differs in the substratum and the nature of the cystidia

17. *Odontia coloradensis* n. sp.

Effused as a thin dull pinkish buff or drab crust that follows the irregularities of the substratum, cracked to the wood into small areas measuring 2 to 4 per mm., the margin thinning out, determinate; hymenium minutely papillate-hydroid, the teeth terminating in minute, white, usually divided tips, visible only under a lens; in section 75-90 μ thick through the subiculum, composed of erect hyphae without any differentiation; spores ellipsoid, broadly ellipsoid, or oblong-ellipsoid, smooth, hyaline, 6.5-8.5 \times 4-6 μ ; cystidia as agglutinated clusters or cylinders of small hyphae, heavily incrustated, 15-30 μ diameter and projecting prominently from the tips of the teeth.

Type collected on dead witch-hazel (*Hamamelis virginiana*), in Bluebell Canon, Colo., elev. 6000 ft., March 9, 1928, by P. F. Shope (421) (Overholts Herb. no. 10995) (PLATE 28, FIG. 5; PLATE 31, FIG. 19).

The distinguishing character of the species is the bundles of incrustated hyphae at the apices of the teeth. Under low power these first give the impression of the large septate incrustated cystidia so often found in species of this genus, but under higher magnification their structure is easily made out.

18. *Odontia corticioides* n. sp.

Effused in small patches, very inconspicuous and following the inequalities of the substratum, ivory yellow or cream-color, becoming minutely areolate on drying, the hymenial surface rough and uneven and without definite teeth; sections 150-200 μ thick, homogeneous, of sub-erect hyphae, hyaline, with very inconspicuous clamps and cross walls, 1.5-2.5 μ diameter; spores cylindric, mostly curved, hyaline, free and on basidia, 7-8 \times 2-2.5 μ ; in some sections there is considerable crystalline

material throughout the subhymenium; in others there is none; cystidia as narrow flexuous hyphae projecting in clusters from the tips of the very inconspicuous granules, these about $2\ \mu$ diameter, sometimes branched and in the subhymenium often traceable as inconspicuous agglutinated cylinders of hyphae.

On dead coniferous wood. Type collected in Estes Park, Colo., in 1926 by E. C. Smith (no. 638) (Overholts Herb. no. 10475); also by the same collector in the same locality, Feb. 12, 1928, and communicated by P. F. Shope (no. 451) (Overholts Herb. no. 11003) (PLATE 28, FIG. 1, PLATE 29, FIG. 6).

I have searched thoroughly through the genus *Corticium* for this species but it seems not to have been described there. I refer it to *Odontia* rather than to *Grandinia* because of the cystidia at the tips of the elevations. The spores ally it with *O. stenospora*, in which, however there are well formed teeth, and cystidia more or less distributed over the hymenium.

In some sections the tufts of cystidial hairs extend downward into the subhymenial tissue as inconspicuous cylinders of agglutinated hyphae not clearly defined and giving the impression of imbedded cystidia or gloecystidia.

19. *Phlebia cervina* n. sp.

Effused in small orbicular patches about 0.5 cm. diameter, and then irregularly confluent over small areas, separable from the substratum and the margin loosening slightly, fleshy-waxy in texture; hymenium "vinaceous-fawn" or "light vinaceous drab" (Ridgway) in color, with irregular domes or short rugae, never conspicuously radiately arranged and with no tendency to a poroid condition; in section 300–600 μ thick, the subhymenium consisting of a dense layer of erect hyphae producing the basidial layer and bearing some few incrustated conical or lance-shaped cystidia 5–7 μ diameter, not projecting strongly beyond the basidia and some of them entirely imbedded; below this a layer of more open and perhaps slightly gelatinous tissue bearing numerous clavate, ovoid, or broadly-ellipsoid gloecystidia with a dense granular content and up to 15 μ diameter; substratal layer a broad zone of more horizontal hyphae; spores cylindric or slightly curved, smooth, hyaline, $5\text{--}6 \times 2\ \mu$.

On bark of limb of *Pinus ponderosa*. Type collected by W. H. Snell, at Ipswich, Mass., Jan. 31, 1929 (763) (Overholts Herb. no. 11484) (PLATE 29, FIG. 14).

In the dried condition this fungus has about the color of *Corticium Overholtsii* Burt, but under a lens shows distinct granules, which on soaking up give the hymenium a typical *Phlebia*-like appearance. It cannot be referred to *Merulius* because of the nature of the hymenium, and no similar species has been described in that genus.

20. *Phlebia mellea* n. sp.

Sporophore resupinate, effused for several centimeters, fleshy-cartilaginous in texture, drying rather cartilaginous, the hymenial surface honey-colored or somewhat ochraceous cinnamon in dried plants, with numerous short radiating and anastomosing or branching conspicuous folds which remain rather distinct in the dried plants; margin rather thick, lacerate-fimbriate and paler (nearly white) in color in the fresh plants; in section 600-1500 μ thick, with substratal layer of loose hyphae sometimes agglutinated into rhizoid like strands, arising from a dense narrow dark zone only 40-60 μ diameter, which in turn gives place to a broad zone of interwoven non-gelatinized hyphae constituting the bulk of the sporophore and bearing the dense basidial layer between and over the folds of its outer surface; spores cylindric, smooth, hyaline, $7-9 \times 3-4 \mu$; cystidia none.

On dead wood or bark of coniferous trees. Type collection collected on a dead Englemann spruce at Grand Mesa, Colo., alt. 10,000 ft., Sept. 12, 1929, by P. F. Shope and W. O. Jung (565) (Overholts Herb. no. 12080). Also collected on dead coniferous wood in Arizona by W. H. Long, in 1916 (Overholts Herb. no. 12081) (PLATE 31, FIGS. 18, 22, 23).

This is an unusually well-marked species in the conspicuous layering of the subhymenial region. The substratal layer of open hyphae resembles that of the tomentose layer of a *Stereum* and may, as in cases of resupinate stereums, indicate that the plant sometimes occurs pileate, though such is very doubtful.

21. *CANTHARELLUS CINEREUS* (Pers.) Fries.

Pileus 3-6 cm. diameter, more or less infundibuliform, the center perforate, the surface radiately rugose and appearing fibrillose-tomentose but practically glabrous under a lens, almost exactly duplicating the color of *Craterellus cornucopioides*, blackening somewhat on drying; margin even; context thin, concolorous; hymenium almost meruloid, but the main veins

radiating outward and connected by prominent cross veins and anastomoses, decurrent on the stem, cinereous; stem hollow, nearly equal, somewhat furrowed, concolorous above with the hymenium, paler below, 4-7 cm. long, 12-20 mm. thick; spores ovoid to ellipsoid, smooth, hyaline, $7.5-9 \times 5.5-6 \mu$; cystidia none.

On the ground in coniferous woods (Overholts Herb. no. 11116) (PLATE 30, FIG. 17).

From the upper surface view this would be thought to be *Craterellus cornucopioides*. As a matter of fact these plants were gathered by Mrs. Overholts along with plants of that species that had been pointed out as desirable to have, and the inclusion of the *Cantharellus* was not noticed until the plants were the next day examined in the laboratory. That it is not a merulioid form of *Craterellus cornucopioides* is evident from a comparison of the spores of the two species. Murrill has referred it as a synonym for *Cantharellus infundibuliformis*, and while the spores are about the same, the hymenial configuration and the entire absence of any yellowish tints to the stem are sufficient to separate it. Ricken holds it distinct, although his illustration does not do justice to the hymenial configuration of my plants. Kauffman does not list the species.

22. NYCTALIS PARASITICA (Bull.) Fries.

Collected Aug. 14, 1929, in Cook Forest, Jefferson Co., Pa., on an old decaying *Russula*, probably *R. nigricans*. Four small specimens of the parasite were fruiting on one plant of the *Russula*. The species differs from the more common *N. asterophora* in the very different spores that are of different shape, lack the spiny wall characteristic of that species, and have the body of the spore surrounded by the unaltered hyphal wall in the form of a sheath. Seymour's host index records this species as occurring on *Russula foetens*. The host for my plants was certainly not that species but one that becomes very black as it decays. Murrill lists only *N. asterophora* Fries as occurring in this country. The following notes were made from the collection:

Pileus 5-15 mm. broad, ~~convex~~, gray or grayish brown, finely-floccose but not conspicuously powdery, dry; margin deflexed; flesh extremely thin, black where bruised; gills adnate, distant,

thick, smoky-gray; stem central, equal, white, blackish where bruised, finely silky-fibrillose, subshining, 1.5-2 cm. long, 1-2 mm. thick; basidiospores not found; chlamydospores numerous, ochraceous-brown, ellipsoid, thin-walled, smooth, $14-16 \times 8-9 \mu$, surrounded by a conspicuous hyaline, hyphal sheath and measuring over all $24-30 \times 8-10 \mu$.

On old decaying *Russula*, probably *R. nigricans* (Overholts Herb. no. 11736) (PLATE 30, FIG. 16).

23. STROPHARIA RUGOSO-ANNULATA Farlow.

Pileus 4.5-8 cm. broad, at first nearly hemispheric, then convex to plane, inclined at times to be unsymmetrical, the unexpanded buttons "dark vinaceous drab" in color, older specimens "benzo-brown" to "fawn color" (Ridgway) usually rather uniformly colored but sometimes slightly lighter in color in the center or in irregular rays on the margin, slightly viscid, slightly and minutely floccose-scaly except at the disk, soon glabrous except on the margin which retains fibrillose traces of the veil; context fleshy, white, 6 mm. or less thick over the stem, thinning out to a few millimeters on the margin, taste and odor not characteristic; gills sinuate-adnate to adnexed, close or somewhat crowded, 4-6 mm. broad, at first "pale gull gray," soon darker and finally "purplish gray" with a whitish edge that becomes more pronounced as the sides of the gills become darker from the maturing spores; stem central, equal or somewhat enlarged at base, glabrous, creamy white becoming yellowed where handled and on drying, stuffed, 7.5-13 cm. long, 0.8-1.5 cm. thick at apex, 1.5-3 cm. thick at base; veil ample, rather thick, creamy white or yellowish, usually leaving a well-formed annulus with unsymmetrical radiating lobes, superior, striate on the upper surface, or occasionally evanescent, leaving only a spore-stained trace on the stem; spores ovoid or ovoid-elliptic, with a minute hyaline papilla usually visible at one end, dark yellow-brown, smooth, $13-15 \times 8-9 \mu$; cystidia present as rather numerous inconspicuous, usually pointed bodies, not projecting strongly beyond the basidia, hyaline, 9-12 μ diameter.

Growing gregariously in the woody debris along the banks of streams. Collected on Penn's Creek, near Ingleby, Center Co., Pa., July 4, 1929, by H. A. Wahl, and at the same station July 13, 1929, by C. S. Parker and H. A. Wahl (Overholts Herb. no. 11692). Collected repeatedly in the vicinity of Washington, D. C., in the fall of 1929 and June, 1930, by C. S. Parker. (PLATE 30, FIG. 15.)

As in *S. bilamellata* and *S. coronilla* the annulus, when well developed, is distinctly striate on the upper side.

Mr. H. A. Wahl reports the species as edible and surpassed in flavor by no other.

In Peck's herbarium at Albany there are two collections of what is apparently this species, one by G. E. Morris at Waban, Mass., 1905, and another by G. B. Fessenden, also from Massachusetts in the same year. The spores of these are a trifle smaller than in my collection, mostly 10–13 μ in length, but an occasional spore is 15 μ long. The cystidia are the same as in my specimens.

NOTE: The above account of this species was compiled during the summer of 1929, and included in this manuscript as a new species under a different name. At that time I had not seen the newly issued *Icones Farlowiana*, and it was not until this manuscript was in galley proof that the priority of Farlow's name was noted. Whereupon, the name assigned to this species in my manuscript was withdrawn but the description allowed to stand as above. I have now eight collections of this species in my herbarium.

24. POLYPORUS ADMIRABILIS Peck.

This handsome white polypore has been very seldom collected outside of New England and New York, where its favorite host is the apple tree, though occasionally found on such other hosts as *Acer* and *Juglans*. A fine large specimen was collected at the base of a large living *Quercus* on the Boal Estate near Boalsburg, Center Co., Pa., June 30, 1929. The habit of this plant was much that of *P. Berkeleyi*, with a tubercular central stem rather than the slender terete stem more typical of smaller specimens. The hymenium becomes blackish where handled—a character not mentioned in the descriptions. The spores (7–9 \times 2.5–3.5 μ) are different from those of species of similar habit. This plant was 30 cm. in diameter, though somewhat larger sizes have been collected. *P. albiceps* Peck is scarcely more than a small form of this species, and *P. Underwoodii* is not distinct (Overholts Herb. no. 11643).

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EXPLANATION OF PLATES

PLATE 28

Fig. 1. *Odontia corticioides*. Vertical section through the hymenial and subhymenial region of a single very convex papilla, showing spores and protruding cystidia. $\times 500$; spores $\times 660$. From type collection.

Fig. 2. *Corticium effusum*. Vertical section through the hymenium and about two-thirds of the underlying subiculum, showing the many ovoid imbedded vesiculose cells and two gloeocystidia reaching the surface of the hymenium. $\times 625$. From type collection.

Fig. 3. *Peniophora piceina*. Vertical section through sporophore showing homogenous subhymenial tissue, three cystidia in the hymenial layer, and spores. $\times 590$. From type collection.

Fig. 4. *Stropharia rugoso-annulata*. Basidial layer, showing cystidia and spores. $\times 510$. (Overholts Herb. no. 11692.)

Fig. 5. *Odontia coloradensis*. Vertical section through a single papilla, showing homogenous nature of the subhymenial region and two bundles of incrustated hyphae protruding at the apex. $\times 585$. From type collection.

PLATE 29

Fig. 6. *Odontia corticioides*. Vertical section through the sporophore, showing the homogenous structure of the subhymenium and the clusters of hair-like cystidia protruding at the apex of each obtuse papilla. $\times 100$. From type collection.

Fig. 7. *Harknessia caudata*. Vertical section of pycnidium. $\times 72$. (Overholts Herb. no. 11030.)

Fig. 8. *Ascochyta Catalpae*. Vertical section through pycnidium. $\times 365$. (Overholts Herb. no. 11663.)

Fig. 9. *Camptium curvatum*. Conidia. $\times 710$. (Overholts Herb. no. 11521.)

Fig. 10. *Tympanis Alnea*. Habit sketch to show cluster of apothecia bursting through the cortex. $\times 7$. (Overholts Herb. no. 10960.)

Fig. 11. *Harknessia caudata*. Spores and appendages. $\times 470$. (Overholts Herb. no. 11030.)

Fig. 12. *Camptium curvatum*. Conidiophores showing conidial scars at apex. $\times 675$. (Overholts Herb. no. 11521.)

Fig. 13. *Tympanis Alnea*. Ascus with bacilliform spores; also a single paraphysis. $\times 513$. (Overholts Herb. no. 10960.)

Fig. 14. *Phlebia cervina*. Vertical section through sporophore, showing the hymenial region with incrustated cystidia, the upper subhymenial region with enlarged gloeocystidia, and the substratal region of homogenous hyphae. $\times 354$. From type collection.

PLATE 30

Fig. 15. *Stropharia rugoso-annulata*. Photo of smaller specimens from Overholts Herb. no. 11692 collection. $\times 1$. Photo by C. S. Parker.

Fig. 16. *Nyctalis parasitica*. Showing three sporophores of the parasite on the pileus of an old decaying *Russula*. $\times \frac{1}{4}$. Photo by C. S. Parker. (Overholts Herb. no. 11736.)

Fig. 17. *Cantharellus cinereus*. Photo showing view of hymenium and stem. $\times 1$. (Overholts Herb. no. 11116.)

PLATE 31

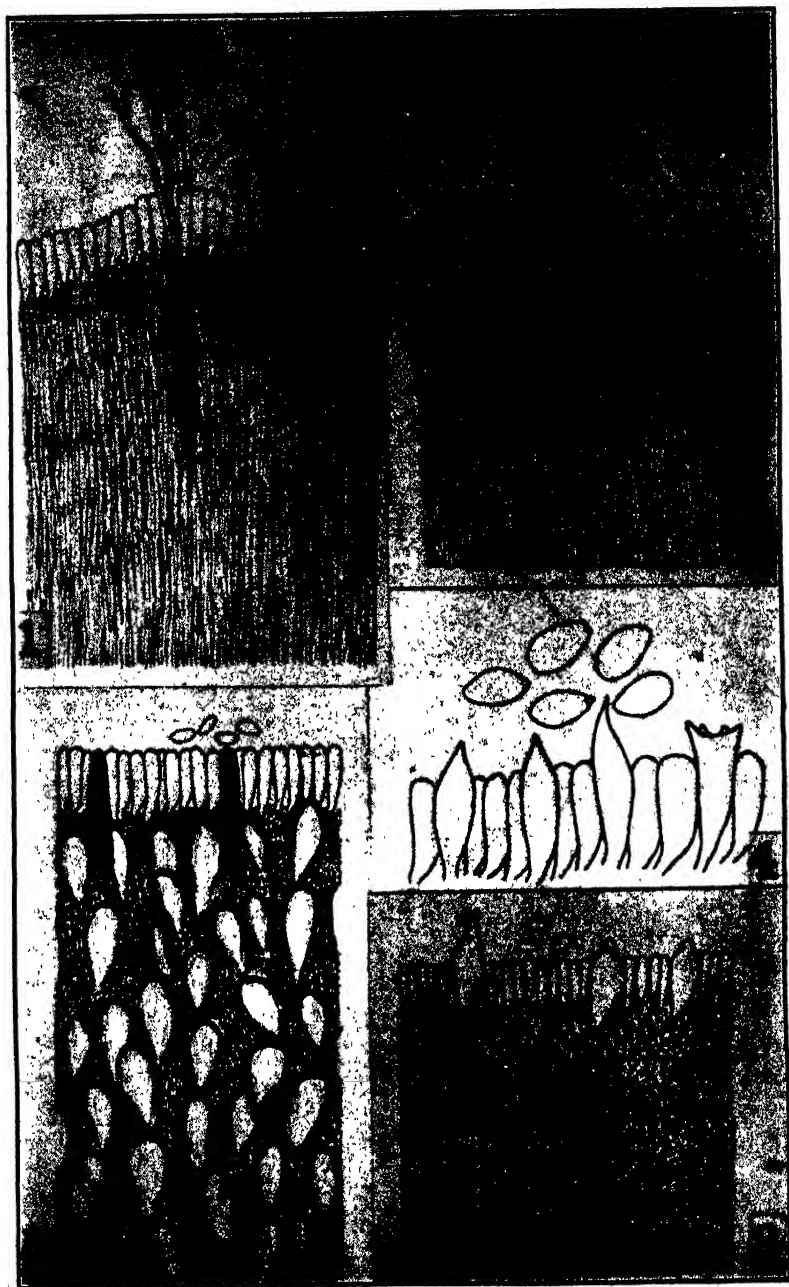
Fig. 18. *Phlebia mellea*. Vertical section through sporophore showing the very evident layering. $\times 84$. (Overholts Herb. no. 12081.)

Fig. 19. *Odontia coloradense*. Vertical section through sporophore, showing the columnar fascicles of hyphae protruding at the apices of the teeth. $\times 150$. From type collection.

Fig. 20. *Otthiella staphylina*. Vertical section through stroma, showing arrangement of perithecia. $\times 107$. (Overholts Herb. no. 11436.)

Fig. 21. *Mollisia pinastri*. Vertical section through apothecium on pine needle. $\times 120$. (Overholts Herb. no. 11704.)

Figs. 22, 23. *Phlebia mellea*. Photo of hymenial surface of type specimen. $\times 1$. Photo by P. F. Shope.

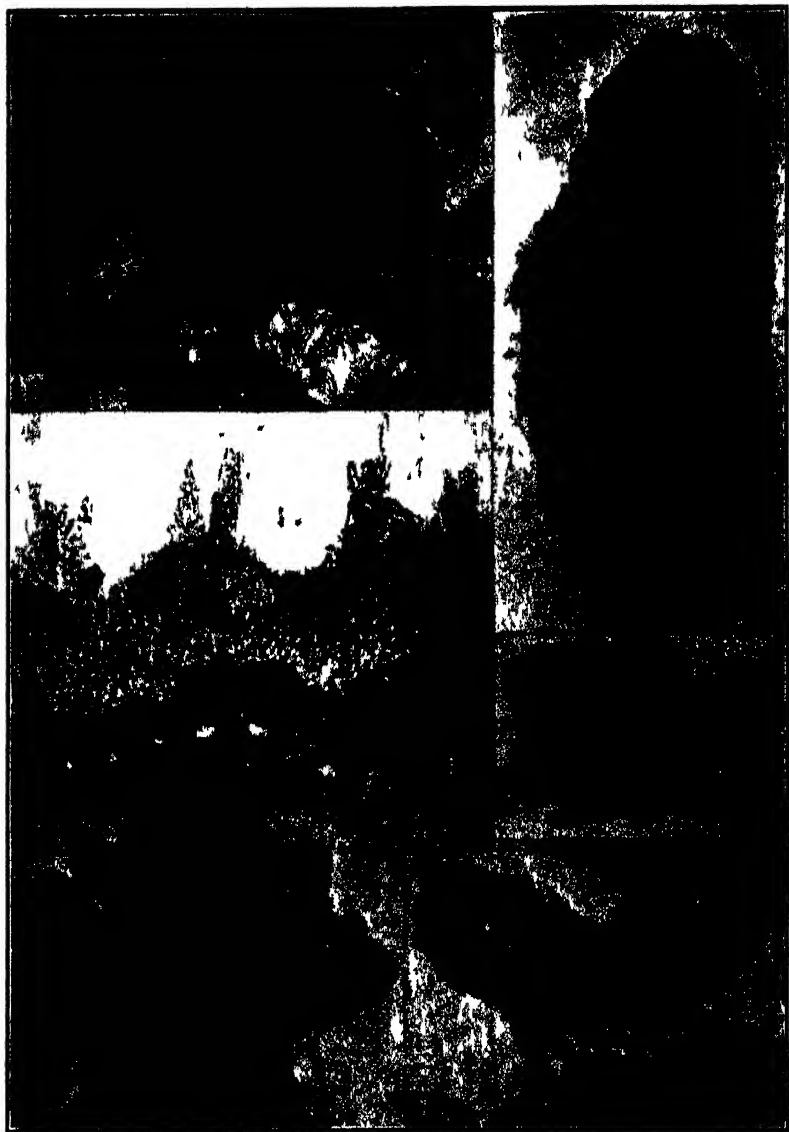


PENNSYLVANIA FUNGI





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NEW SPECIES OF LICHENS FROM PORTO RICO—IV¹

JOYCE HEDRICK

As planned by the author of the first paper² of this series, the second and third papers have been published by Doctor E. A. Vainio and Doctor A. Zahlbruckner respectively. It is the writer's privilege to present this miscellaneous group of new species by various authors as the fourth paper.

The types are deposited in the Herbarium of the University of Michigan, as are also the types of the species listed in the first paper of this series, and cotypes of those in the second and third papers.

1. *Porina Vainii* Fink, n. sp.

Thallus indistinct, immersed in the substratum, and showing at the surface as a greenish gray to whitish coloration; perithecia small to middle-sized, 0.6–0.8 mm. across, semisuperficial and scattered, the superficial portion subhemispherical and black, the perithecial wall globose and complete, the ostiole minute and indistinct; hymenium hyaline; paraphyses hyaline, distinct to semidistinct, unbranched or rarely branched toward the apices; asci cylindric to narrowly clavate; spores 8, hyaline, ovoid-oblong to fusiform, 1-septate, the cells cylindric, $10-14 \times 4.5-5.5 \mu$, uniseriately arranged.

The algal host is *Trentepohlia*.

On rocks on an exposed hilltop near Yauco, Fink 1431 (type). Also on limestone near Trujillo Alta, Britton 8659, 8662, 8664, collected in 1926.

2. *Pseudopyrenula confluens* G. K. Merrill, n. sp.

Thallus thin, smooth, ashy, more or less bordered and dissected by black lines; perithecia small to middle-sized, 0.4–0.8 mm. across, black, slightly immersed in the substratum to superficial,

¹ Papers from the Herbarium of the University of Michigan, No. 15.

² Number III of this series was published by A. Zahlbruckner, *Mycologia*, 22: 69–79. 1930.

the superficial portion spheroidal and often slightly flat or subconical, the perithecial wall dimidiate, the ostiole inconspicuous; hypothecium often tinged with brown; hymenium hyaline; paraphyses hyaline, branched and interwoven; asci clavate, the wall moderately thickened in the apical region; spores 8, hyaline, oblong-elliptic, 3-septate, the cells lenticular, $16-18 \times 5-5.5 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On bark in a wood near Aibonito, Fink 1856 (type). Also near Maricao, Britton and Cowell 4289, collected in 1915.

3. *Pseudopyrenula portoricensis* Hedrick, n. sp.

Thallus very thin, greenish gray to whitish about the perithecia, somewhat shining; perithecia minute, 0.15–0.24 mm. across, wholly or largely immersed in the substratum and the thallus, often clustered, little more than the minute and indistinct, blackish ostiole showing, the perithecial wall thin and complete; hymenium hyaline; paraphyses hyaline, distinct, branched and interwoven; asci broadly clavate, the wall scarcely thickened in the apical region; spores 8, hyaline, oblong, 3-septate, the cells lenticular, $16-21 \times 7-8 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On bark in a wood near Mayaguez, Fink 1025 (type). Collected near Santurce, Mr. and Mrs. A. A. Heller 1287, in 1899 and E. G. Britton 1474, in 1914; near San Juan, Britton and Wheeler 298, in 1906; near Bahia Puerco, Britton and Britton 8838b, in 1927.

4. *Mycoporellum deserticola* Fink, n. sp.

Thallus thin, smooth, light greenish gray to ashy; perithecia small to middle-sized, 0.3–1 mm. across, adnate, black, flat to slightly convex, circular in outline to slightly irregular, the chambers 10–20, each indicated by a very minute, papilliform elevation, the perithecial wall dimidiate; hymenium and hypothecium hyaline or the latter tinged with brown; paraphyses hyaline, few and soon breaking down; asci subpyriform, the wall much thickened in the apical region; spores 8, hyaline to brownish, elliptic-soleaeform, 1–3-septate, the cells cylindric, $21-25 \times 6.5-8 \mu$, irregularly arranged.

The algal host is *Palmella*.

On shrubs on exposed hilltop near Yauco, Fink 1688 (type). On *Coccolobis*, Guayanilla, Dr. and Mrs. N. L. Britton 7192, collected in 1923.

5. *Arthonia minutula* Fink, n. sp.

Thallus very thin, smooth, more or less continuous, ashy white; apothecia very minute, 0.05–0.08 mm. across, immersed to adnate, round to irregular, the disk concave to flat, brownish black to black; hypothecium and hymenium hyaline; paraphyses hyaline, indistinctly branched and interwoven; asci subglobose, the wall slightly thickened in the apical region; spores 8, hyaline, elliptic to long-elliptic, 7–9-septate, the cells cylindric, $45\text{--}54 \times 15\text{--}21 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

On trees, Isabel Segunda to Cerra Encanta, Vieques Island, J. A. Shafer 2564, collected in 1914.

6. *Gymnographoidea suborbicularis* Fink, n. gen. and n. sp.

Thallus thin, smooth to somewhat rough, becoming chinky and minutely areolate, continuous and widespread, greenish gray to ashy; apothecia minute, 0.1–0.25 mm. across, immersed to partly superficial, round, the disk concave to flat, black, the exciple appearing thin and brown in section; hypothecium and hymenium hyaline; paraphyses hyaline, slender, unbranched or furcately branched toward the apices; asci clavate; spores 8, hyaline, elliptic-dactyloid, 3-septate, the cells cylindric, the second cell from one end larger, $15\text{--}18 \times 4\text{--}5.5 \mu$, biserially to irregularly arranged.

The algal host is *Trentepohlia*.

Gymnographoidea differing from *Arthonia* by the definite round apothecia and the thin brown proper exciple.

On bark in a wood near Rio Piedras, Fink 2194.

7. *Leucogymnospora intricata* Fink, n. gen. and n. sp.

Thallus very thin to thin, smooth, closely adnate to the substratum, olive green to ashy gray; apothecia short to longer but very narrow, $0.6\text{--}2.5 \times 0.12$ mm., immersed, curved to flexuous and sometimes branched, irregularly clustered, the disk appearing as a narrow black line, closed to rarely opened, the exciple thin to thick, colored like the thallus; hypothecium and hymenium hyaline; paraphyses hyaline, unbranched, slender, several-septate; asci clavate; spores 8, hyaline, elliptic to oblong-elliptic, with a heavy wall, 3-septate, the cells rectangular, $20\text{--}23 \times 7.5\text{--}8.5 \mu$, irregularly arranged.

The algal host is *Trentepohlia*.

Leucogymnospora differing from the genera of the *Graphidaceae*

by the immersed apothecium without a proper exciple, and by the unbranched paraphyses and the hyaline spores with rectangular cells.

On bark in a wood near Rio Piedras, Fink 2193.

8. *Melaspilea elutericola* Fink, n. sp.

Thallus imbedded in that of the host and invisible; apothecia oblong, straight, small and narrow, $0.5-0.7 \times 0.04-0.06$ mm., adnate, unbranched, usually conglomerate in flat black areas, usually many in a group, the groups $0.5-3.5$ mm. across, round to irregular, the disk rarely seen as a black, depressed line or slightly open, but the individual apothecia more often scarcely discernible in the groups; hypothecium and exciple dark brown in section and of moderate thickness; hymenium hyaline below and brownish above; paraphyses rather slender, hyaline below with brownish apices, unbranched and becoming indistinct, especially below; asci clavate, the wall considerably thickened in the apical region; spores 8, brown, 1-septate, slightly constricted, the upper cell slightly larger, $15-17 \times 7.5-8.5$ μ , irregularly arranged.

The algal host is *Trentepohlia*.

On *Trypethelium eluteriae* Spreng. near Montalva, Britton, Cowell and Brown 4837, collected in 1915.

9. *Micrographina palmicola* Fink, n. gen. and n. sp.

Thallus composed of hyphae imbedded in the algal host and appearing as small, round or irregular, radiately branched, ashy gray areas; apothecia minute, $0.2-0.3$ mm. across, adnate, the disk flat to slightly convex, black, the exciple thin, colored like the thallus; hypothecium and hymenium hyaline; paraphyses hyaline, moderately thick, unbranched or rarely branched toward the apices; asci short clavate, the wall little thickened in the apical region; spores 8, hyaline, dactyloid, 3-septate, the cells cylindric, the second cell from one end wider, $17-23 \times 4.5-5$ μ , irregularly arranged.

The algal host is *Phyllactidium*.

Micrographina differing from *Melaspilea* in the superficial position with reference to the substratum, the hyphae imbedded in the algal host above the tissues of the leaf.

On leaves in a wood near Rio Piedras, Fink 484a and 502 (type).

10. *Psorotichia heterocarpa* G. K. Merrill, n. sp.

Thallus thin, blackish, scattered, granulose; apothecia minute to small, 0.1–0.3 mm. across, adnate, very numerous, scattered or crowded, hemispherical to conical and irregular, the exciple blackish, nearly closed or receding slightly and showing a dark, slightly concave disk; hypothecium pale yellowish brown; hymenium hyaline; paraphyses hyaline, coherent, indistinct; asci clavate; spores 8, hyaline, oblong-elliptic, non-septate, $14\text{--}20 \times 8.5\text{--}10 \mu$, irregularly arranged.

The algal host is *Xanthocapsoid*.

On rocks on an open hillside near Yauco, Fink 1629.

11. *Psorotichia Vainii* Fink, n. sp.

Thallus thin, often scattered, dusky grayish; apothecia minute, 0.1–0.2 mm. across, adnate, the exciple reddish and darkening, covering the disk or receding slightly and showing an impressed, reddish disk; hypothecium and hymenium hyaline; paraphyses hyaline, coherent, distinct; asci clavate; spores 8, hyaline, oblong-elliptic, non-septate, $13\text{--}20 \times 5\text{--}8 \mu$, uniseriately to irregularly arranged.

The algal host is *Xanthocapsoid*.

On rocks on a dry hilltop near Yauco, Fink 1525.

12. *Biatorina leucoblepharoides* G. K. Merrill, n. sp.

Thallus very thin, smooth, ashy gray, in small to middle-sized, irregular, more or less scattered areas; apothecia minute to small, 0.15–0.4 mm. across, adnate, frequently irregular, the disk flat, black, the exciple thin, entire, black, often surrounded by a soon disappearing thalloid layer; hypothecium becoming dark brown; hymenium hyaline; paraphyses hyaline, coherent, semidistinct; asci clavate; spores 8, hyaline, oblong-elliptic, 1—rarely 2- or 3-septate, $7\text{--}9.5 \times 1.8\text{--}3 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On leaves of grapefruit in an orchard near Manati, Fink 2127.

13. *Bilimbia Stevensonii* Fink, n. sp.

Thallus thin, minutely granulose or appearing minutely powdery, continuous or scattered into small, irregular areas, bright sulphur-yellow; apothecia very minute, 0.08–0.2 mm. across, adnate to almost sessile, round to somewhat irregular, often clustered, the disk flat to slightly convex, bright yellow, the exciple covered with minute, thalloid granules; hypothecium and

hymenium hyaline; paraphyses hyaline, unbranched, free, usually short and often indistinct; asci broadly clavate and becoming enlarged toward the apices, or ventricose at maturity of the spores; spores 8, hyaline, elliptic to finger-shaped, 3-septate, more or less constricted at the middle septum, the middle cells usually larger, $13-16 \times 3.5-4 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On bark near Rio Piedras, J. A. Stevenson 5163 (type), collected in 1916 and Fink 87.

This peculiar thalloid appearance has been found elsewhere but always without the apothecia.

14. *Catillaria epiphylla* Fink, n. sp.

Thallus thin, smooth to minutely granulose, continuous or scattered in small irregular areas, yellowish gray to ashy; apothecia minute, 0.08–0.2 mm. across, adnate, round to somewhat irregular, the disk flat to convex, flesh-colored or rarely whitish pruinose, the exciple thin, colored like the disk, soon disappearing; hypothecium and hymenium hyaline; paraphyses hyaline, slender, unbranched or branched toward the apices; asci clavate, the wall somewhat thickened in the apical region; spores 8, hyaline, elliptic, pointed at one end and somewhat obtuse at the other, 1-septate, the cell toward the obtuse end larger, $12-16 \times 4-5 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On leaves near Mayaguez, F. L. Stevens 1101a, collected in 1913.

15. *Catillaria Zahlbruckneri* Fink, n. sp.

Thallus thin to moderately thick, ashy, sometimes tinged light brown, scurfy-granular to chinky-areolate, the areoles sometimes scattered, smooth, becoming rough, frequently showing a black hypothallus; apothecia minute to small, 0.2–0.6 mm. across, adnate, often clustered, the disk convex to irregular, the surface becoming rough, black, the exciple black, soon disappearing; hypothecium hyaline above and brown below; hymenium hyaline; paraphyses hyaline, distinct; asci clavate; spores 8, hyaline, oblong-elliptic, 1-septate, $6-9.5 \times 2.5-3 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On limestone on an open hilltop near Yauco, Fink 1502.

16. *Lecidea granulifera* Fink, n. sp.

Thallus thin, minutely granulose, forming a continuous, pale greenish gray to dirty white crust; apothecia small to middle-

sized, 0.6–1 mm. across, sessile, round to irregular, the disk flat to slightly convex, reddish brown or somewhat whitish pruinose, the exciple thin, colored like the disk, soon disappearing; hypothecium reddish brown; hymenium hyaline above to reddish brown below; paraphyses hyaline, stout, unbranched, semi-distinct; asci clavate; spores 8, hyaline, oblong-elliptic, non-septate, $5-6 \times 2.5 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On rocks at 600–720 meters at Rio de Maricao, Britton and Cowell 4235, collected in 1915.

17. *Lecidea gymnocarpa* Fink, n. sp.

Thallus thin and smooth to thicker and somewhat rough about the apothecia, white to brownish; apothecia minute, 0.1–0.2 mm. across, semi-immersed to superficial and adnate, round, the disk flat, brownish black to black, the exciple very thin, colored like the disk and soon disappearing; hypothecium and hymenium hyaline; paraphyses hyaline, unbranched or rarely branched toward the apices; asci broadly clavate to sub-pyriform; spores 8, hyaline, ovoid, non-septate, $6.5-8 \times 4.5-5 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On exposed roots of cocoanut palm near Naranjito, Fink 345.

18. *Lecidea prolifera* Fink, n. sp.

Thallus thin to moderately thick, rough, minutely granulose, greenish gray to ashy; apothecia small to large, 0.5–1.5 mm. across, adnate, the disk flat to slightly convex, reddish brown to brownish black, the exciple colored like the disk and sometimes disappearing, small apothecia proliferating from the larger old ones and resting upon them, the old exciple, hypothecium and hymenium persisting; hypothecium dark brown; hymenium hyaline below and sometimes brownish above; paraphyses hyaline, unbranched; asci clavate; spores 8, hyaline, oblong-elliptic, non-septate, $12-14 \times 7-8 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On trees, Indiera Fria, near Maricao, Britton, Cowell and Brown 4397, collected in 1915.

19. *Lecidea Zahlbruckneri* Fink, n. sp

Thallus rather thick, ashy gray to pale lead-colored, chinky-areolate, more or less scattered; apothecia minute to small, 0.2–0.6 mm. across, partly immersed in raised areas of the thallus, the disk flat to convex, black, the inconspicuous black exciple soon

disappearing; hypothecium and hymenium hyaline; paraphyses hyaline, coherent, semidistinct; asci clavate; spores 8, hyaline, ovoid-elliptic, non-septate, $7-10 \times 4-6.5 \mu$, irregularly arranged

The algal host is *Protococcoid*.

On rocks in an open field near Naranjito, Fink 226.

20. **Lopadium biatorellum** G. K. Merrill, n. sp.

Thallus very thin, smooth, grayish to whitish; apothecia minute, 0.1–0.3 mm. across, sessile, the disk flat to slightly convex, dusky brown, the exciple thin, paler, soon disappearing; hypothecium dark brown; hymenium tinged brownish; paraphyses hyaline, coherent, semidistinct; asci clavate; spores 1, tinged brownish, oblong-elliptic, muriform, 13–19-septate transversely and 1–3-septate longitudinally, $50-63 \times 16-20 \mu$.

The algal host is *Protococcoid*.

On sticks in a wood near Mayaguez, Fink 1156.

21. **Lecanora elabens** G. K. Merrill, n. sp.

Thallus rather thick, ashy gray, squamulose-areolate, the squamules minute, sometimes indistinctly lobed; apothecia small, 0.2–0.5 mm. across, sessile, the disk concave to slightly convex, brownish to brownish black, the exciple prominent, colored like the thallus, entire to irregular; hypothecium and hymenium hyaline; paraphyses hyaline, coherent, indistinct, enlarged and brownish at the apices; asci clavate; spores 8, hyaline, short-elliptic, non-septate, $9-10 \times 5.5-6.5 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On rocks on an open hill near Aibonito, Fink 1946

22. **Lecanora nigrolimitata** Fink, n. sp.

Thallus thin, composed of minute to small, greenish gray to ashy, warty granules, crowded into an irregular, chinky-areolate crust, more or less scattered toward the circumference upon a broad, black hypothallus; apothecia small to middle-sized, 0.3–0.8 mm. across, adnate to sessile, round to irregular and crowded, the disk concave to flat, black, the exciple colored like the thallus, thin, entire to crenulate, very rarely disappearing; hypothecium and hymenium hyaline; paraphyses hyaline, unbranched and free; asci clavate; spores 8, hyaline, oblong-elliptic, non-septate, $12-14 \times 7-8 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On rocks in a valley, Desecheo Island, Britton, Cowell and Hess 1650, collected in 1914.

23. *Lecanora portoricensis* Fink, n. sp.

Thallus thin, closely adnate, in round to irregular areas, becoming chinky-areolate and sometimes disappearing toward the center, distinctly lobed toward the circumference, yellowish to ashy; apothecia minute to small, 0.2–0.5 mm. across, adnate, the disk flat to slightly convex, black, the exciple thin to thick, colored like the thallus; hypothecium and hymenium hyaline; paraphyses hyaline, unbranched or branched toward the enlarged and sometimes colored apices; asci broadly clavate; spores 8, hyaline, elliptic, non-septate, $12-14 \times 4-5 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On limestone at Morrillos de Cabo Rojo, Britton, Cowell and Brown 4728 and 4729 (type), collected in 1915.

24. *Buellia Finkii* G. K. Merrill, n. sp.

Thallus moderately thin, sordid greenish gray, rough and scurfy, becoming chinky-areolate; apothecia small to middle-sized, 0.3–0.8 mm. across, sessile, the disk flat to strongly convex, black, the exciple black, rather thick, finally disappearing; hypothecium reddish brown with a hyaline zone above; hymenium hyaline; paraphyses hyaline, coherent, semidistinct; asci clavate; spores 8, brown, oblong-elliptic, 1-septate or rarely 3-septate, $15-21 \times 8-11.5 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On rocks on an eastward exposure at an altitude of 2100 feet, near Aibonito, Fink 1884

***Buellia substigmatea* Fink, n. sp.**

Thallus thin, rough, composed of minute to small, greenish gray to ashy granules, crowded into a more or less continuous, chinky-areolate crust; apothecia minute, 0.05–0.2 mm. across, numerous, adnate to sessile, round to irregular, scattered or clustered, the disk flat to convex, black, the exciple thick, colored like the disk, sometimes disappearing; hypothecium dark brown; hymenium hyaline below and tinged brownish above; paraphyses hyaline, unbranched; asci clavate; spores 8, brown, elliptic, 1-septate, $10-14 \times 5-6 \mu$, irregularly arranged.

The algal host is *Protococcoid*.

On rocks of rocky hill, Christiansted, St. Croix, Britton, Britton and Kemp 79, collected in 1923.

MYCETOZOA FROM JONES BEACH STATE PARK

ROBERT HAGELSTEIN

Long Island, in the State of New York, is fringed on the south by a series of ocean beaches, the best known of which are Coney Island, Rockaway Beach, and Long Beach. East of Long Beach, and separated therefrom by Jones Inlet, is Jones Beach. Part of this is now a State Park and connected with the mainland of Long Island by a causeway extending over five miles of intervening water and meadow. The beach otherwise is completely surrounded by water and is about thirteen miles long. It is very narrow, in some places only a few hundred feet wide, the greatest width being less than one mile.

This narrow sandy waste, with low beach vegetation, has no trees, and would seem to be a poor place for the development of the Mycetozoa. However, they may be found in sheltered spots usually close to the sand where moisture is retained; but the fruitings are not so numerous nor as large as in more favored locations.

The writer has a summer cottage in the colony known as High Hill Beach which colony is within the limits of the State Park. Three-quarters of the species enumerated have been found within a few hundred feet of this cottage, on decaying grasses close to the sand, on partly buried driftwood, paper, clothing, and other rubbish strewn about the beach. Similar habitats, also logs, boards, dead herbaceous stalks, and bayberry leaves, at other points within a short distance, have provided the remaining species.

The collections have been made over a limited area for several years past. It is probable that more extended search over this and similar beaches may yield other interesting forms. Seven of the fifty-eight species and varieties recorded have not been found by the writer on the mainland of Long Island.

The writer is ~~deeply~~ indebted to Miss G. Lister for the determinations and verifications mentioned in this paper, and for the

many freely expressed comments on specimens sent to her at various times; also, to Prof. Thomas H. Macbride and Dr. William C. Sturgis for aid so frequently extended, which has made possible a better understanding of this interesting group.

1. *ARCYRIA CINEREA* (Bull.) Pers.

Common on partly buried driftwood and boards. The sporangia of one fruiting are somewhat clustered, approaching var. *digitata* (Schw.) G. Lister, and a distinctly yellow variety of the typical form was found twice. Numerous fruitings of minute, scattered sporangia occur on decaying grasses. These are subglobose or ovate in shape and sometimes pinkish in color.

2. *ARCYRIA DENUDATA* (Linn.) Wetts.

Common on wood and paper rubbish.

3. *ARCYRIA INSIGNIS* Kalchbr. & Cooke.

On grasses and dead stalks in September; well distributed and abundant. The var. *dispersa* described by the writer (*Mycologia* 21: 298. 1929) occurred again at various places in 1929.

4. *ARCYRIA NUTANS* (Bull.) Grev.

On dead wood.

5. *ARCYRIA POMIFORMIS* (Leers) Röst.

Common on driftwood.

6. *BADHAMIA FOLIICOLA* Lister.

Collected on dead grasses in July and September 1928 and September 1929. The species has also been found at other places on Long Island, so apparently is not rare. It is distinguished from others with which it may be confused by the short, yellow, filamentous stalks and the free spores, when these characters are present. Frequently the sporangia are sessile, or the spores show a tendency to adhere, but as the species forms small plasmodia with numerous fruitings, it is not difficult to find typical examples. The original determination was made by Miss Lister and she has verified one of the Jones Beach collections.

7. *CERATIOMYXA FRUTICULOSA* (Muell.) Macbr.

The type form and the var. *flexuosa* Lister are abundant, on decaying driftwood, during the early summer months.

8. *COMATRICHA ELEGANS* (Racib.) Lister.

Specimens of this species with depressed globose sporangia, but characteristic capillitium were found on the inner side of the weathered boards of an old structure, in company with *C. nigra* to which it is related. About thirty species of Mycetozoa were collected in, on, and immediately surrounding this structure which was about six feet square and four feet high.

9. *COMATRICHA LAXA* Rost.

On dead wood.

10. *COMATRICHA NIGRA* (Pers.) Schröt.

Not uncommon on old wood.

11. *COMATRICHA PULCHELLA* (Bab.) Rost.

On dead beach grasses.

12. *COMATRICHA TYPHOIDES* (Bull.) Rost.

On driftwood.

13. *CRATERIUM LEUCOCEPHALUM* (Pers.) Ditmar.

A beautiful fruiting of var. *scyphoides* (Cooke & Balf.) Lister was found on horse dung and the surrounding grass in July 1928. The typical form and var. *cylindricum* have not been seen on the beach, although they are common in other parts of Long Island. The var. *scyphoides* was verified by Miss Lister.

14. *CRIBRARIA ARGILLACEA* Pers.

Abundant in August 1928 at various stations on partly buried wood.

15. *CRIBRARIA INTRICATA* Schrad.

Rare; but the var. *dictyidioides* (Cooke & Balf.) Lister is more abundant. Perfect developments of the variety as found on the beach seem to confirm its specific position as maintained by Macbride and other students.

16. *CRIBRARIA MINUTISSIMA* Schw.

This species, beautifully matured, appeared on a prostrate telephone pole under holly berry bushes in July 1928, and has not been collected by the writer elsewhere on Long Island. The determination was verified by Miss Lister.

17. CRIBRARIA TENELLA Schrad.

On wood; the var. *concinna* G. Lister also occurs. The determinations are based on the interpretations of the species as expressed by Miss Lister and Dr. W. C. Sturgis.

18. CRIBRARIA VULGARIS Schrad.

On dead wood.

19. DICTYDIUM CANCELLATUM (Batsch) Macbr.

Observed frequently on driftwood during the summer months. The var. *fuscum* Lister with small brown sporangia and distinct cup, was collected twice. This seems to be the same as var. *cancellatum* Macbr.

20. DIDERMA EFFUSUM (Schw.) Morg.

Common on bayberry leaves in the thinly effused phase and the rounded sporangia or plasmodiocarps. The latter are var. *reticulatum* Rost.

21. DIDERMA RADIATUM (Linn.) Morg.

Represented by a single collection of var. *umbilicatum* (Pers.) Meylan.

22. DIDERMA SIMPLEX (Schröt.) Lister.

Collected repeatedly on dead grasses and bayberry leaves in July 1928.

23. DIDYMIUM CLAVUS (Alb. & Schw.) Rab.

Common on grasses and bayberry leaves. The determination was confirmed by Miss Lister.

24. DIDYMIUM MELANOSPERMUM (Pers.) Macbr.

Two fruitings of small, depressed, sessile sporangia, frequently confluent and forming plasmodiocarps, are doubtfully placed with var. *minus* of this species. The spores are thick-walled, purple-brown in color, and measure 9 to 9.5 μ ; the absence of a columella indicates a relationship to *D. clavus* in whose company the specimens were found.

25. DIDYMIUM SQUAMULOSUM (Alb. & Schw.) Fries.

On corrugated box rubbish. One specimen of otherwise normal stipitate sporangia shows a number of curious cylindrical plas-

modiocarps from 2 to 4 mm. in length, and with recumbent stalks at each end which extend through the plasmodiocarps and are connected as continuous, solid columellae.

26. *ENERTHENEMA PAPILLATUM* (Pers.) Rost.

Developed twice in successive years on the inner wall of the old structure previously mentioned.

27. *FULIGO SEPTICA* (Linn.) Weber.

Large aethalia are frequent on old rubbish and corrugated paper boxes, the last a modern habitat. Small aethalia, from 2 to 3 cm. in size, are on grasses.

28. *HEMITRICHIA CLAVATA* (Pers.) Rost.

On dead wood.

29. *HEMITRICHIA SERPULA* (Scop.) Rost.

On cotton textile debris.

30. *HEMITRICHIA VESPARIUM* (Batsch) Macbr.

On cotton textile debris.

31. *LAMPRODERMA SCINTILLANS* (Berk. & Br.) Morg.

Frequent in July and August on decaying beach grasses. Some developments have sporangia normal in size with short stalks, but in most cases the sporangia are minute on relatively long stalks. Sporangium size .15 to .3 mm.; total height .6 to .7 mm. One fruiting was on the claw of a dead crab.

32. *LINDBLADIA EFFUSA* (Ehr.) Rost.

Appeared at several places in July 1928 and again in 1929, the best developments in large effused aethalia, on old clothing partly buried in sand, and in close proximity to several fruitings of *Cribraria argillacea*.

33. *LYCOGALA EPIDENDRUM* (Buxb.) Fries.

On dead wood and cardboard.

34. *OLIGONEMA NITENS* (Lib.) Rost.

A single small fruiting on wood.

35. *OPHIOTHECA VERMICULARIS* (Schw.) Macbr.

This is the most abundant species on Jones Beach. In August and September it develops everywhere on dry herbaceous stems.

36. *PHYSARUM BOGORIENSE* Racib.

Typical sporangia and plasmodiocarps of this species were found on decaying grasses in September 1928. The determination was confirmed by Miss Lister.

37. *PHYSARUM CINEREUM* (Batsch) Pers.

On paper rubbish and leaves during July. Macbride gives the spore size in this species as from 6 to 7 μ . This does not apply to specimens from Long Island where the species is extremely abundant and the spores invariably much larger, from 8 to 10 μ or more and usually almost smooth. The spores from the Jones Beach paper gathering are 9.5 to 11 μ in diameter, pale, and almost smooth.

38. *PHYSARUM COMPRESSUM* Alb. & Schw.

On banana stems; July.

39. *PHYSARUM GALBEUM* Wingate.

On grasses and bayberry leaves. The species is probably not uncommon as it has been collected frequently in other parts of Long Island, but it is inconspicuous and difficult to find, the small fruitings consisting rarely of more than a dozen sporangia. The dense, almost lime-less capillitium varies considerably in color, from distinct yellow to pale, almost hyaline.

40. *PHYSARUM MAYDIS* (Morg.) Torrend.

On dead grasses. Determined by Miss Lister.

41. *PHYSARUM MELLEUM* (Berk. & Br.) Mass.

Common on bayberry leaves and stalks, in September.

42. *PHYSARUM NUTANS* Pers.

On dead wood.

43. *PHYSARUM PUSILLUM* (Berk. & Curt.) Lister.

On the stems and leaves of a living plant; September.

44. *PHYSARUM VIRIDE* (Bull.) Pers.

Common on wood; var. *incanum* Lister also occurs.

45. *STEMONITIS FUSCA* Roth.

Not uncommon on drift wood.

46. *STEMONITIS SMITHII* Macbr.

On cotton textile debris. The small sporangia and the constant habit of forming small plasmodia seem to the writer sufficient to separate this form specifically from *S. axifera*.

47. *STEMONITIS SPLENDENS* Rost.

During the early summer of 1925, two irregular forms appearing superficially like *S. splendens* but more rusty in color, were found on widely separated logs thrown up by the tides. The spores are alike, 7 to 8 μ in diameter, light in color, and warted. The sporangia of one specimen have meagre capillitia with no surface nets. The columellae are weak so that eventually the sporangia collapsed into a mass of spores. This is var. *flaccida* (Morg.) Lister.

The second specimen has strong stalks and columellae, sparse capillitia, but well developed surface nets with large meshes up to 150 μ in width, and is var. *Webberi* (Rex) Lister.

For the present, these forms are considered as varieties of *S. splendens*.

48. *TRICHIA PERSIMILIS* Karst.

Large fruitings of this common species were taken from an old cotton mattress on the sand.

49. *TRICHIA VARIA* Pers.

On dead wood.

50. *TUBIFERA FERRUGINOSA* (Batsch) Gmel.

A common species found everywhere on decaying driftlogs.

MINEOLA, NEW YORK

NOTES AND BRIEF ARTICLES

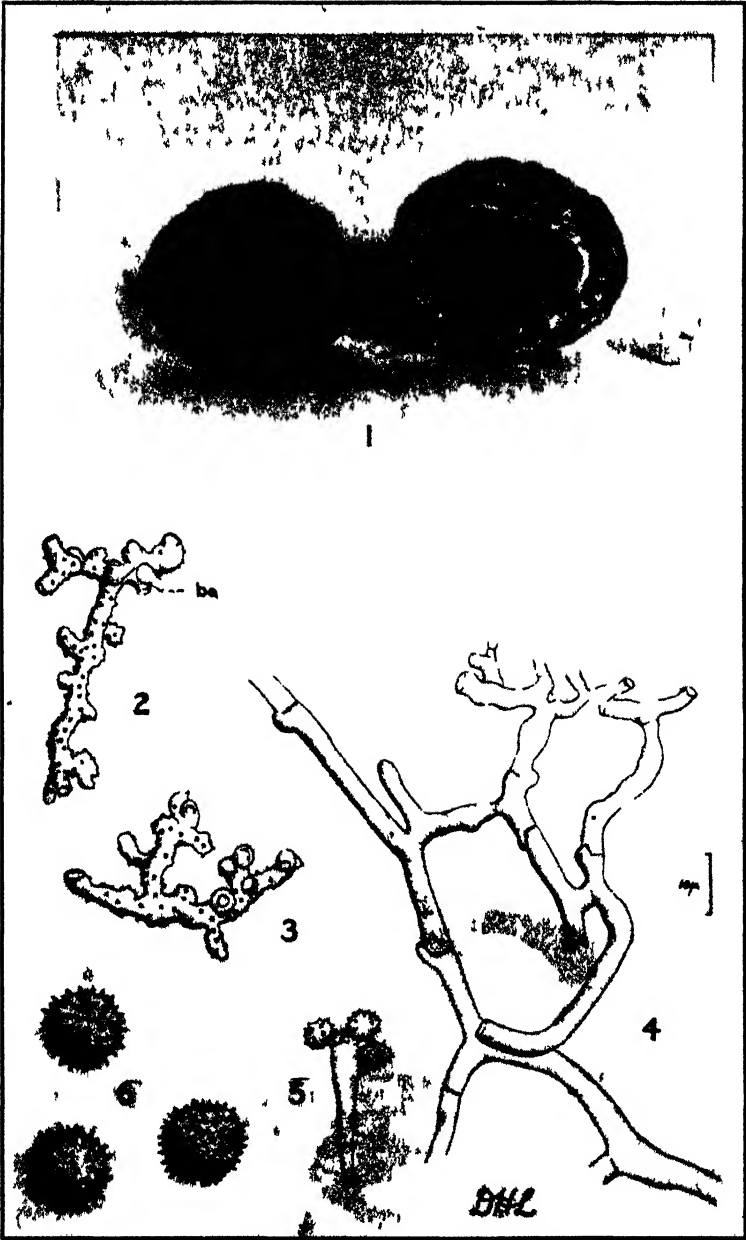
Mr. Carl C. Lindegren, teaching fellow of the California Institute of Technology at Pasadena, California, spent the month of July at the New York Botanical Garden where he pursued his genetical studies on the species of the *Monilia* molds belonging to the Ascomycete genus *Neurospora*.

LAMPRODERMA CRIBRARIOIDES (Fries) R. E. Fries. This striking alpine species, characterized by its large, dark, strongly reticulate spores is represented by a generous collection on herbaceous stems, gathered at Middle Boulder, Colorado, by Fred J. Seaver and Paul F. Shope (No. 40) in the late summer of 1929. It is known from a number of localities in Europe but this seems to be its first recorded occurrence elsewhere.—G. W. MARTIN.

Dr. B. O. Dodge, Pathologist at the New York Botanical Garden, is attending the International Botanical Congress held at Cambridge, England. He is taking part in a symposium on the significance of heterothallism and hybridism in fungi, and is reading a paper on Inheritance of the Albinistic Non-conidial Character in Interspecific Hybrids in *Neurospora*. He will spend some time traveling in Europe visiting various culture laboratories where he will make some studies on the fungi causing human diseases. He expects to return to New York about the middle of October.

A brief paper on Cytological Features of the Life History of *Gymnosporangium Juniperi-virginianae* by Miss Edith Stevens appeared in the June number of the Botanical Gazette. It is interesting to note that the figures and descriptions of the origin and development of the teliospores include a description of buffer cells as terminal cells of the parenchymatous growth of the young sorus, the teliospore proper arising from a subterminal cell. There is nothing in the paper to indicate that the presence of buffer cells in the telial sorus of these forms is not reported for the first time.

It might be pointed out, however, that buffer cells in telial sori of the *Gymnosporangia* were first described and figured in the Brooklyn Botanical Garden Memoirs (1: 128-140, 1918). One of the figures describing these structures has been copied in such works as Arthur's Plant Rusts. The telial sorus of *Gymnosporangium Juniperi-virginianae* was also described and figured in Mycologia (10: 182-193, 1918), where a full plate illustration of the young sorus of this species showing continuous rows of buffer cells will be found. Buffer cells in the sori of *G. clavipes* are described in the in the American Journal of Botany 9: 354-365, 1922. Buffer cells in the telial sorus of *G. bermudianum* are also noted by Thurston in a paper published in the Botanical Gazette (75: 236, 1923).—B. O. DODGE.



TREMELLOGASTER SURINAMENSIS

MYCOLOGIA

VOL. XXII NOVEMBER–DECEMBER, 1930 No. 6

NOTES ON TREMELLOGASTER SURINAMENSIS

DAVID H. LINDER

(WITH PLATES 22 AND 23)

Tremellogaster surinamensis was first collected in Surinam by Dr. Gerold Stahel during an expedition up the Saramacca River. This material was sent to Ed. Fischer, who described it (2) as belonging to a new genus and species, tentatively assigned to the Lycoperdaceae. Two years after the species was first collected, the writer in 1924 again discovered it at Koreai Creek, a short distance above Bartica on the Essequibo River in British Guiana. Peculiarly enough, the species was growing under almost the same conditions reported for the original material, namely at the foot of a hill bordering a swamp on moist sandy soil near a decaying log. The extension of range and the ecological conditions, however, are of minor consideration in this paper, since its main purpose is to throw additional light on the structure, development, and classification of this rare and unusual fungus.

Because of the maturity of the material available to him for study, Fischer was unable to make out the development of the species, especially in regard to the gleba. In the present studies a similar handicap exists, for while the material is considerably less mature than that studied by Fischer, nevertheless stages from the development of the primordium to the immature gleba are lacking and make impossible an accurate determination of the development of the fruiting body. On this account, only inferences can be made as to the origin of certain structures, based on the evidence present in the more advanced but still immature material at hand.

[MYCOLOGIA for September–October (22: 215–264) was issued August 29, 1930]

As stated by Fischer, the peridium appears to be formed by the differentiation of the outer layer of the hyphal strands on which the primordium was produced. This outer layer, in the peridium of the more advanced stages, has become differentiated into three zones. The outer one is characterized by a thin layer of dark, heavy-walled, twisted, sclerotoid hyphae (PLATE 23, FIG. 7) which gradually gives way internally to thin-walled, hyaline hyphae that run almost parallel to the surface. The middle and most conspicuous zone is brownish and gelatinous, divided into irregular polygonal areas by plates of non-gelatinous tissue. The inner or third zone is composed of hyaline mycelium that intertwines and also runs approximately parallel to the surface of the fruiting body. The mycelium of the inner zone is further characterized by the irregular transverse thickenings of the cell walls, as stated by Fischer.

Because of the fact that the peridium of mature material appeared to be distinct from the gleba, Fischer was led to believe that the two tissue systems developed separately—one from the outer layer of the mycelial strand, the other from the inner layer or medulla. There is additional evidence for this assumption, for if the hyphae of the middle zone of the peridium, next to the inner and outer zones, are studied it can be seen from the orientation of the numerous clamp connections (PLATE 23, FIG. 11) that the middle zone is formed by centrifugal growth from the inner zone and centripetal growth from the outer one. The inner polygonal areas of the gelatinous zone appear to have been formed first, since they are larger and the hyphae are more scattered, while in the outer part of the zone the irregular gelatinous areas are smaller and the hyphae more closely packed. Presumably the hyphae have not secreted as much gelatinous material and are therefore less distantly separated. The reduction in size of the polygonal "fields" is clearly shown on the upper part of the sectioned fruiting body shown in figure 1 of plate 22. These are apparently formed from the outer layer of the peridium as is evidenced by loculi found in this tissue where the cavities are filled with a mucilaginous material which strongly suggests that found in the middle zone.

The gleba in mature specimens is quite distinct and is free from

the inner layer of the peridium. In the younger specimens, however, there is a loose connection between the two tissues brought about by a few scattered hyphae from the inner layer of the peridium penetrating into the gleba. In the even earlier stages of the development of the gleba it appears that there was a loose mass of rather stout mycelium, (3.1)–4.5–5.4 μ diam., the elements of which were loosely branched and had anastomosed rather frequently. Clamp connections were also formed in relative abundance (PLATE 22, FIG. 4). These hyphae, in material available for study, appear to have been compressed by the growth of the numerous fertile areas to which they have given rise. The majority of the hyphae have lost their protoplasmic content, but here and there may be found a few that still retain their cytoplasm and which are readily stained by the cotton blue in the lacto-phenol mounting medium.

The fertile areas do not appear to have arisen in the manner stated by Fischer (2) for the Clathraceae and by Cunningham (1) for *Lycoperdon depressum*. Evidence of the ingrowth of tramal plates or special tissue is absent. Instead, the ends of the branches of the coarse hyphae become richly and irregularly short-branched in definite areas and there aggregate to form the dense subhymenial layer of the individual fertile mass. More than one of the coarse hyphae is involved in this process so that the fertile area is surrounded by hyphae of the former loose mass, but these hyphae have become inconspicuous through compression and it is only by crushing and separating the material that they can be made out.

The subhymenial layer is 5 to 9 μ thick and composed of very densely aggregated elements. At maturity, however, the original hyphae with the clamp connections have practically disappeared, as have also the basidia. As a result, the subhymenial layer in the dried and mature gleba becomes loosened and somewhat separated. During the process, the walls of the subhymenial elements have become somewhat thicker and sparsely though conspicuously warty-spinulose (PLATE 22, FIGS. 2, 3), and thus modified appear to be comparable in function but not in development with the capillitium of *Lycoperdon*. For lack of a better term these structures may be called pseudo-capillitia.

The basidia, forming an hymenial layer of approximately $20\ \mu$ in thickness, arise directly from the much branched subhymenial elements. They are extremely transparent and are stained only with considerable difficulty. Unless the sections are carefully crushed so as to separate the densely aggregated basidia, an individual basidium is extremely difficult to find. When isolated, however, they are found to be clavate or nearly cylindrical with the apical end slightly larger than the basal end, and are $20\text{--}22 \times 5\text{--}5.5\ \mu$. Each basidium (PLATE 22, FIG. 5) bears four sterigmata on which the spores are produced. The basidiospores are at first hyaline and sparsely echinulate, but with maturity become enlarged, spherical, brown, and more densely echinulate. Occasionally under the higher powers of the microscope, the spores may be seen to be pedicillate from the persisting hyaline remnants of the sterigmata.

DISCUSSION

From the foregoing account, it appears that Fischer was thoroughly justified in not considering this genus as belonging to the Clathraceae since the absence of tramal plates in the development of the gleba would preclude such an affinity. On the other hand, this same character would also exclude this form from the Lycoperdaceae in which he tentatively placed it. In addition, the lack of a true capillitium and of large glebal chambers would seem to place the species in another family. In figure 4, plate 22, it is clear that the hyphae of the glebal fundament have given rise locally to hyphal knots which are comparable to those observed by Rabinowitsch (3) for *Scleroderma bovista*. It therefore seems preferable to consider *Tremellogaster surinamensis* a member of the Sclerodermataceae, rather than of the Lycoperdaceae.

DESCRIPTION

In view of the more complete data available, it seems desirable to add to the original description of the species as follows:

TREMELLOGASTER SURINAMENSIS Ed. Fischer.

Fruiting body 4–7 cm. diam., "Clay Color"¹ below, becoming "Bistre" above, "Russet" to "Deep Mars Brown" in dried

¹ Ridgeway, R. * Color Standards and Color Nomenclature. Washington, D. C., 1912.

material, the surface coarsely flattened-tuberculate, more conspicuously rounded-tuberculate above. Mycelial strands "Clay Color." Peridium up to 1 cm. thick, with an outer zone of thick-walled, colored sclerotoid hyphae bordered internally by thin-walled, hyaline to subhyaline hyphae that run approximately parallel with the surface of the fruiting body; a middle conspicuous brownish gelatinous zone, reticulately divided by lighter colored non-gelatinous tissue; and a white inner zone of non-gelatinous tissue that consists of hyphae that intertwine and run more or less parallel, the cell walls wrinkled by transverse thickenings. The gleba, at first "Warm Buff," becoming "Hays Brown" and powdery. Pseudocapillitium of varying length, $2.5-4\ \mu$ diam., much branched, hyaline, sparsely warty-spinulose. The basidia forming a palisade-like hymenium, clavate, tapering towards the base, $20-22 \times 5-5.5\ \mu$, with four short sterigmata. The basidiospores globose, echinulate, dark brown, $5-6\ \mu$ diam., occasionally minutely and inconspicuously pedicellate.

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EXPLANATION OF PLATES

PLATE 22

All drawings are made with the aid of a camera lucida.

Fig. 1. Fruiting bodies of *Tremellogaster surinamensis*. Note the greater development of the peridium at the summit of the longitudinally cut fruiting body at the right. The outer and smaller irregular gelatinous areas appear to have been formed after the inner and larger ones by addition from the outer zone of the peridium. From freshly collected specimens; Figs. 2-3. Pseudocapillitium from the mature gleba. At *ba* may be seen a remnant of a basidium. Approx. $\times 800$; Fig. 4. The much branched and anastomosing hyphae of the glebal fundament. Above and at the right, the branches become irregularly and frequently branched to form the subhymenial layer, which is partly indicated by dotted lines, as is the hymenial layer. The dark portions of the hyphae indicate where the protoplasm still persists. Note the abundance of clamp connections. From material soaked in dilute sodium hydroxide and crushed under the coverglass in lactophenol. Approx. $\times 800$; Fig. 5. A clavate basidium bearing four immature spores. Approx. $\times 800$; Fig. 6. Basidiospores from mature material. Approx. $\times 1850$.

PLATE 23

All photographs, except fig. 12, are made from sections cut $10\ \mu$ thick and stained with Delafield's *Haematoxylin*.

Fig. 7. Photograph to show the thin outer peridium composed of deeply stained, thick-walled, sclerotoid hyphae, and a portion of the middle zone that is divided by a plate of non-gelatinous tissue; Fig. 8. The inner zone of the peridium composed of parallel strands of hyphae, from which has arisen a plate of non-gelatinous tissue. The non-gelatinous plates that arise from the inner zone of the peridium are mostly denser than those from the outer zone; Fig. 9. A portion of the gleba next to the inner layer of the peridium. Note that the basidia form a dense palisade-like layer that is only slightly stained. The subhymenial layer is scarcely visible; Fig. 10. Low power of the peridium illustrating the formation of the smaller gelatinous areas in the outer portion of the middle zone. It is these smaller areas that give the fruiting body its coarsely tuberculate appearance; Fig. 11. Hyphae arising from the inner zone of the peridium. The arrows point to clamp connections which, as can easily be seen, indicate that the hyphae have grown outward; Fig. 12. A portion of the gleba, showing basidiospores in fours. The arrow points to a remnant of the glebal primordium. From material in lactophenol crushed under the cover-



7



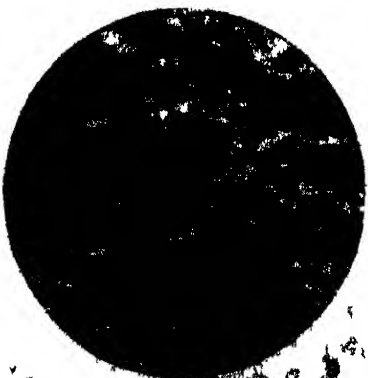
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11



NEW FUNGI FOUND ON THE INDIAN CORN PLANT IN ILLINOIS

G. L. STOUT

(WITH PLATE 24)

Of the sixteen new species that have been found, fourteen are associated with spots on the leaves of corn and two have been found on the stalks at or near the basal nodes. Although the pathogenicity of none of them has been tested by inoculation methods, it seems likely that at least those found on the leaf-spots are responsible for the particular lesions with which they are associated. Of the two that occur on the stalk, *Helminthosporium zeicola* shows some indication of being a parasite, but the nature of the other species is doubtful. None of the sixteen fungi appear to be of any considerable economic importance as plant pathogens, although taken collectively they may play a minor part as such by reducing the photosynthetic area of their host. Again, it should be remembered that their appearance is usually quite late in the season and toward the end of the life of the corn plant, when they are likely to have little effect on the yield. In a study of them, however, some are found to present some very interesting mycological problems, particularly in relation to their life cycles and the possible relationship between perfect and imperfect forms.

The genera and species are presented in alphabetical order. The type specimens are deposited in the herbarium of the State Natural History Survey of Illinois, at Urbana, and they are designated each by an accession number and a notation as to the place and date of collection, as may be noted in the descriptions given below.

Ascochyta Maydis n. sp.

Pycnidia located in a tiny patch on a large, effuse, translucent, dead area of the leaf, developed subepidermally, opening either epiphyllously or hypophyllously by a minutely papillate ostiole, dark-brown, membranous, their walls composed of a pseudo-

parenchyma, lenticular, 75–150 μ in diameter; ostiole rounded, 7.5–15 μ across, the ostiolar papillum of smaller cells and appearing darker than the wall of the pycnidial body. Spores two-celled, hyaline, long-ellipsoid to fusoid, rarely slightly constricted at the septum, 11–18 \times 3–4.5 μ . (PLATE 24, FIG. 1.)

On leaves of *Zea Mays* L.

Type specimen: Macomb, McDonough County, Illinois. October 11, 1926. Nat. Hist. Surv. Acc. No. 19688.

Percy, Randolph County, Illinois. November 9, 1927. Nat. Hist. Surv. Acc. No. 21204. In this specimen, the spores were somewhat broader and shorter than in the type, measuring up to 10–16 \times 5 μ . They were distinctly septate and slightly constricted at the septum, and they emerged in cirri from the pycnidia when the latter were mounted in water on the microscope slide.

Only the two collections have been made.

Ascochyta Zeae n. sp.

Spots at first ellipsoid, becoming elongated and somewhat irregular, sometimes confluent, the leaf veins tending to bound them laterally, their margins brown and well defined to fading, their interiors becoming tan-cinereous. Pycnidia moderately abundant, developed subepidermally, sometimes in rows between the microscopic leaf veins, opening either epiphyllously or hypophyllously, often through the stomata, by a minutely papillate ostiole, dark-brown, membranous, their walls composed of an indistinct pseudoparenchyma, lenticular, 55–160 μ in diameter; ostiole rounded, 6.5–18 μ across, the ostiolar papillum appearing darker than the wall of the pycnidial body. Spores obscurely uniseptate, the septum often apparently lacking, hyaline, oblong-ellipsoid to somewhat irregular, rarely constricted at the septum, 8.5–13.5 \times 3–4.5 μ . (PLATE 24, FIG. 2.)

On leaves of *Zea Mays* L.

Type specimen: Mount Carmel, Wabash County, Illinois. November 9, 1926. Nat. Hist. Surv. Acc. No. 19581. Collected only once.

Two other species of *Ascochyta* have been described as occurring on corn, from which the two species above may be distinguished as follows.

On stalks

Spores $6-8 \times 1.5-2 \mu$ *A. zeicola*

On leaves

Spores $8.5-13.5 \times 3-4.5 \mu$ *A. Zeae*Spores $11-18 \times 3-4.5 \mu$ *A. Maydis*Spores $18 \times 7.5 \mu$ *A. zeina***Coniothyrium Zeae** n. sp.

Spots at first ellipsoid, becoming elongated and irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan colored, their margins brown and well marked to somewhat fading, their interior becoming lighter. Pycnidia located in the mesophyll, opening by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, $130-150 \mu$ in diameter; ostiole rounded, $12-30 \mu$ across, the ostiolar papillum appearing darker than the pycnidial wall. Spores one-celled, brown-olivaceous, their walls dark and well marked, long-ellipsoid, often presenting one nearly flattened and one curved side, $8.5-13.5 \times 4.4-6.6 \mu$. (PLATE 24, FIG. 3.)

On leaves of *Zea Mays* L.

Type specimen: Putnam, Putnam County, Illinois. October 6, 1926. Nat. Hist. Surv. Acc. No. 19686.

Casey, Clark County, Illinois. October 24, 1927. Nat. Hist. Surv. Acc. No. 21159. In this specimen, the pycnidia were somewhat larger than in the type, measuring up to 230μ across, but the spores were entirely typical.

Only the two collections have been made, but these were in widely separated parts of the State.

Although its spores have the color and form of *Sphaeropsis* spores, this fungus is placed in *Coniothyrium* for two reasons: (1) the spores are too small for a *Sphaeropsis*; (2) there are no conspicuous conidiophores.

This fungus differs from *Sphaeropsis ambigua* Mont., also found on corn, by its smaller spores, those of *S. ambigua* measuring $15 \times 5 \mu$.

Helminthosporium zeicola n. sp.

Caulicolous; occurring in a dark-olivaceous effuse patch at and below the first node above the uppermost roots. Sporophores superficial, chocolate-brown to black-olivaceous, arising singly or in groups of two to four, usually about 6.5μ in diameter but ranging from 5.5 to 7.7μ wide by 160 to more than 300μ long, up

to 15 or more septate at intervals of $8.5\text{--}45\ \mu$, the spores produced at or between the septa at the apices of well marked geniculations, the first spore produced at $75\text{--}165\ \mu$ or more from the base and successive spores at intervals of $6.5\text{--}45\ \mu$, the basal end of the basal cell of the sporophore swollen as into a bulb usually about twice the diameter of the base of the sporophore. Spores concolorous with the sporophores to dilute-olivaceous, narrow-ellipsoid to subcylindrical, widest near the middle or basal part, often tapering considerably to the rounded ends, straight to slightly curved, rarely irregular or abruptly bent, three to eleven septate, rarely constricted at the septa, the hilum external and sometimes obscure, $33\text{--}115 \times 10\text{--}17\ \mu$, germination in tap water by end cells within several hours. (PLATE 24, FIG. 4.)

On stalk of *Zea Mays* L.

Type specimen: Dixon, Lee County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. 19884.

Eichorn, Hardin County, Illinois. October 21, 1926. Nat. Hist. Surv. Acc. No. 20180. This specimen was associated on the culm with an irregular, water-soaked spot which had a definite to fading brownish margin, the spot occurring at and extending below the stalk node. The sporophores were much longer than in the type, measuring up to more than $500\ \mu$, and they had more septa. Bipolar germination of the spores occurred in tap water within several hours.

Mount Carroll, Carroll County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. 20182. This specimen was associated with a very irregular, grayish-black spot at the stalk node, with the mycelium in places extending into the pith and darkening the tissue. Bipolar germination of the spores occurred in tap water within several hours.

Shelbyville, Shelby County, Illinois. November 16, 1926. Nat. Hist. Surv. Acc. No. 20181. This specimen was associated with a dark-gray, irregular spot on the stalk at the topmost root node and extending out on a prop root, which it appeared to have rotted. The sporophores were sometimes of greater basal diameter than in the type and somewhat longer, measuring up to $8.5\ \mu$ in diameter by more than $400\ \mu$ long. Bipolar germination of the spores occurred in tap water within several hours.

As may be noted by the four collections indicated, this fungus has been found in widely scattered parts of the State.

Although this fungus seems to closely fit the *Helminthosporium* stage of *Ophiobolus heterostrophus* Drechsler, the author hesitates to consider it identical without knowledge of any perfect stage of it. It will be noted that *H. zeicola* has always been found on the stalk nodes, while Drechsler's fungus is associated with a leaf spot, and he makes no mention of its appearance on culms, although the latter may not necessarily be of any great significance. Until it may be proved that the two fungi are identical, the author is setting his fungus aside under the name *Helminthosporium zeicola*.

Leptosphaeria Maydis n. sp.

Foliicolous; spots at first ellipsoid, becoming elongated and somewhat irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first grayish-tan-colored, their margins brownish and well marked to fading, their interior becoming cinereous. Perithecia not abundant, located in the mesophyll, often in rows between the microscopic leaf veins, opening either epiphyllously or hypophyllously, sometimes through the stomata by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, 50–150 μ in diameter; ostiole rounded, 12–24 μ across, the ostiolar papillum appearing darker than the perithecial body. Asci subcylindrical, straight to curved, short-stiped, their walls hyaline and somewhat thickened at the apex, 50–66 \times 8.5–11 μ . Paraphyses obscure, hyaline, filamentous, exceeding the mature asci. Spores eight per ascus, often with one at each end of the ascus and the other six arranged biserially, greenish-yellow to olivaceous, four-celled, narrow-elliptical to narrow-fusiform, straight to curved, very slightly constricted at the septa, 15–22 \times 4–5.5 μ .

On leaves of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. 19423.

Shelbyville, Shelby County, Illinois. November 16, 1926. Nat. Hist. Surv. Acc. No. 19669. In this specimen, when pressure was applied to the perithecium, the hymenium emerged *en masse* with the asci and paraphyses remaining *in situ*. The paraphyses were definitely observed to exceed the mature asci in length. The asci were larger than in the type, measuring 45–84 \times 11.5–13.5 μ .

Moline, Rock Island County, Illinois. October 8, 1926. Nat. Hist. Surv. Acc. No. 19716. Here the paraphyses measured up

to 100 μ long by 13 μ wide. Associated in the same spot with this specimen and appearing on the same slide was *Septoria Zeae*.

Streator, La Salle County, Illinois. September 23, 1926. Nat. Hist. Surv. Acc. No. 19671. In this specimen the spores were wider than in the type, measuring up to $22 \times 6.5 \mu$. The asci were larger than in the type, measuring up to $80 \times 13.5 \mu$.

This was associated on the same spot with *Septoria Zeae*, the latter showing on the same slide with the *Leptosphaeria*. On the same leaf also was *Phyllosticta Zeae*.

Elgin, Kane County, Illinois. September 24, 1926. Nat. Hist. Surv. Acc. No. 19725. Here the spores were longer than in the type, measuring up to $24.2 \times 5.5 \mu$. The asci were larger than in the type, measuring up to $77 \times 13.2 \mu$.

This was associated on the same spot with *Septoria Zeae*, the latter showing on the same slide.

Mount Carmel, Wabash County, Illinois. October 6, 1927. Nat. Hist. Surv. Acc. No. 21223.

This fungus has been collected six times, in the above noted six counties in widely scattered parts of the State.

The frequent and intimate association of *Leptosphaeria Maydis* and *Septoria Zeae* suggests that these two may be the perfect and imperfect forms of the same fungus.

***Leptosphaeria variiseptata* n. sp.**

Foliicolous; spots at first ellipsoid, becoming elongated and somewhat irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan-colored, their margins brownish to fading, their interior finally becoming cinereous. Perithecia located in the mesophyll, opening either epiphyllously or hypophyllously but not amphiphyllously by a minutely papillate ostiole, dusky brown, membranous, composed of a pseudoparenchyma, globose, 90–150 μ in diameter; ostiole rounded, up to 26.5 μ across, the ostiolar papillum appearing darker than the perithecial body. Asci subcylindrical to subclavate, straight to curved, sessile to very short-stiped, the wall hyaline and slightly thickened at the apex, $45-55 \times 11-13.5 \mu$. Paraphyses hyaline, filamentous, about 2 μ in diameter, exceeding the mature asci in length. Spores eight per ascus, arranged biserially, olivaceous, four- to six-celled, the number of septa differing within a single ascus, suboblong to long-fusoid, widest at the second or third cell from the tip and tapering to the rounded ends, sometimes

slightly curved, hardly constricted at the septa, $18.5-24.5 \times 4.5-6.5 \mu$.

On leaves of *Zea Mays* L.

Type specimen: Roscoe, Winnebago County, Illinois. September 25, 1926. Nat. Hist. Surv. Acc. No. 19726.

Carmi, White County, Illinois. November 10, 1926. Nat. Hist. Surv. Acc. No. 19727.

These two collections were made in widely separated counties, in the northern and southern parts of the State.

This fungus differs from the preceding by its larger asci and spores and by the variable septation of the latter.

***Leptosphaeria Zeae* n. sp.**

Foliicolous; spots at first ellipsoid, becoming elongated and irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan-colored, their margins brownish to fading, their interior finally becoming cinereous. Perithecia located in the mesophyll, sometimes in rows between the microscopic leaf veins, opening either epiphyllously or hypophyllously, often through the stomata, by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, $60-130 \mu$ in diameter; ostiole rounded, $18-29 \mu$ across, the ostiolar papillum appearing darker than the perithecial body. Asci sub-cylindrical, straight to curved, sessile to short-stiped, the wall hyaline and somewhat thickened at the apex with an apparent pore inside in immature asci, $50-66 \times 10-13.5 \mu$. Paraphyses obscure, hyaline, filamentous. Spores eight per ascus, usually with one spore at each end of the ascus and the other six arranged biserially, brown-olivaceous, three-celled, oblong with rounded ends, the basal cell slightly narrower and longer and tapering to its rounded end, slightly constricted at the septa, $13-22 \times 4.5-5.5 \mu$. (PLATE 24, FIG. 5.)

On leaves of *Zea Mays* L.

Type specimen: Sandoval, Marion County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. 19421.

Clay City, Clay County, Illinois. November 8, 1926. Nat. Hist. Surv. Acc. No. 19422.

In this specimen, an occasional spore showed failure to develop one of the septa, resulting in a one-septate spore with an extra large (long) tip cell.

Shelbyville, Shelby County, Illinois. November 16, 1926.

Nat. Hist. Surv. Acc. No. 19661. Here the spores were often much more deeply constricted than in the type, so that the individual cells of the spore assumed a nearly spherical form. On the slide, numerous free single cells were seen which apparently were individual cells of the spores which had readily broken apart, although their identity was not definitely proved. In one case a spore was observed with what appeared to be the tip cell in the process of breaking away at the septum.

Crab Orchard, Williamson County, Illinois. October 8, 1927. Nat. Hist. Surv. Acc. No. 21228.

The above four collections were in counties scattered over the southern half of the State.

This species differs from the two preceding by its three-celled spores.

***Leptothyrium Zeae* n. sp.**

Foliicolous; pycnidia hypophyllous, not gregarious but occurring in small patches, sometimes on elongate-oblong tan-colored spots which are bounded laterally by the leaf veins, subcuticular and possibly subepidermal, circular, dimidiate, dark-brown, membrano-subcarbonous, parenchymatically-reticulate, 55–225 μ in diameter, ostiole lacking. Spores one-celled, hyaline, irregularly globose, sometimes with one or more flattened sides, 8.5–13.5 μ , their walls somewhat thickened. (PLATE 24, FIG. 6.)

On leaves of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. 19445.

Sullivan, Moultrie County, Illinois. November 16, 1926. Nat. Hist. Surv. Acc. No. 19670. This specimen agrees with the above in all characters except the size of the spores, which measure 4.5–8.5 μ . These seemed to be immature.

Bellevue, Calhoun County, Illinois. November 7, 1927, occurring on the same spot and preserved on the same slide with *Mycosphaerella zeicola*. Nat. Hist. Surv. Acc. No. 21154.

The three collections all came from the south central part of the State.

***Mycosphaerella zeicola* n. sp.**

Spots elongate-ellipsoid, becoming somewhat irregular, the leaf veins tending to bound them laterally, their margins brownish to

fading, their interior grayish-tan-colored. Perithecia hardly gregarious but occurring in patches, located in the mesophyll, sometimes in rows between the microscopic leaf veins, opening hypophyllously, sometimes through the stomata. by a minutely papillate ostiole, brown, membranous, composed of a pseudo-parenchyma, globose or flattened-globose, 70–110 μ in diameter; ostiole rounded, 14–28 μ across, the ostiolar papillum appearing darker than the perithecial body. Asci cylindrical, straight to curved, tapering at base to a short stipe, their walls hyaline and somewhat thickened at the apex, 33–55 \times 11–14 μ . Spores eight per ascus, arranged biserially, hyaline to greenish, two-celled, subellipsoid to subfusoid, the tip cell largest and tapering to a rounded apex, the other cell narrower, usually shorter, and tapering to a rounded end, markedly constricted at the septa, 11–18 \times 4–6 μ . (PLATE 24, FIG. 7.)

On *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. 13803.

Bellevue, Calhoun County, Illinois. November 7, 1927. Nat. Hist. Surv. Acc. No. 21154. Asci longer than in the type and measuring up to 66 \times 14 μ . On the same slide and on the same spot with this specimen was *Leptothyrium Zeae*.

Bruce, Moultrie County, Illinois. October 21, 1927. Nat. Hist. Surv. Acc. No. 21194. The pycnidia opened epiphyllously in this specimen.

Champaign, Champaign County, Illinois. September 23, 1927. Nat. Hist. Surv. Acc. No. 21151. In this specimen the spots were definite and elongated, the perithecia were slightly larger than in the type, measuring up to 135 μ across, with their diameter 2 to 3 times their depth, ostiole up to 33 μ , and the spores measuring from 3.5–6 \times 11.5–17 μ . On the same slide appeared typical spores of *Septoria Zeae*.

Effingham, Effingham County, Illinois. September 20, 1927. Nat. Hist. Surv. Acc. No. 21166. On same slide from same spot was *Phyllosticta Zeae*, of which the spores emerged in a cirrus.

Gibson City, Ford County, Illinois. October 4, 1926. Nat. Hist. Surv. Acc. No. 19697. Perithecia measure up to 130 μ in diameter.

Harrisburg, Saline County, Illinois. October 10, 1927. Nat. Hist. Surv. Acc. No. 21212. Perithecia epiphyllous, measuring

mostly 100–110 μ but in one instance up to 130 μ . Asci mostly typical, but occasionally measuring up to $66 \times 15 \mu$, and, in one instance, $83 \times 14 \mu$. Spores somewhat wider than in the type, measuring up to 6.5 μ by 19 μ long.

Mattoon, Coles County, Illinois. September 15, 1927. Nat. Hist. Surv. Acc. No. 21164. Epiphyllous (nearer to upper surface as seen by hand lens).

Minonk, Woodford County, Illinois. September 29, 1926. Nat. Hist. Surv. Acc. No. 19685. Spots much more definite than in the type. Perithecia epiphyllous.

McLeansboro, Hamilton County, Illinois. November 10, 1926. Nat. Hist. Surv. Acc. No. 20136. This specimen occurred in the same spot and appeared on the same slide with *Septoria zeicola*. (See above accession number under the latter species.)

Mount Carmel, Wabash County, Illinois. October 6, 1927. Nat. Hist. Surv. Acc. No. 21222. Typical but epiphyllous.

Riverton, Sangamon County, Illinois. October 19, 1927. Nat. Hist. Surv. Acc. No. 21216. Asci measure up to 76 μ , and spores measure $15 \times 6.5 \mu$.

West City, Franklin County, Illinois. November 12, 1926. Nat. Hist. Surv. Acc. No. 19629. Associated in the same spot and on the same slide with this specimen were *Septoria zeicola* and *Phyllosticta Zeae*.

In addition to the above, this fungus has been collected five other times, in five different counties, making a total of 18 collections in various parts of the southern two-thirds of the State.

Phaeocytospora n. gen.

A genus of the tribe Phaeosporae, of the family Sphaerioidaceae, of the order Sphaeropsidales, of the Fungi Imperfecti. Stromata superficially carbonous, oblong to elongate-oblong, at times irregular in outline, sometimes confluent, becoming erumpent, loculate, all locules joined by openings at the bottom, one to several locules opening through the same ostiole, one to several beaked ostioles per stroma. Spores one-celled, brown, produced at the tips of simple sporophores which line the entire inner surface of the labyrinthine, locular, stromate structure.

Phaeocytospora Zeae n. sp.

Caulicolous; not maculicole. Stromata numerous, gregarious, sometimes confluent, occurring in a region 50 by 7 mm., which ex-

tends lengthwise of the host stalk just above the topmost root node, oblong to narrow-elongate and often irregular in outline, developed subepidermally but at maturity becoming almost wholly erumpent, superficially carbonous, dark-brown under the microscope, in section showing a semicarbonous cortical region and a pseudoparenchymatous interior within which the pycnidial locules lie. Locules usually several per stroma, well defined though often very imperfect and formed by undulations of the stroma wall, joined together at the bottom, opening through a common ostiole; ostioles one to three or more arranged in a fairly regular row lengthwise of the stroma, in section appearing (when the locular divisions are not well defined) as though several ostioles opened from one large chamber coextensive with the stroma, beaked, the beaks $100\text{--}165\ \mu$ high by $100\text{--}125\ \mu$ wide, the openings $40\text{--}45\ \mu$ across. Spores one-celled, long-ovoid, the basal end often markedly attenuate, at maturity becoming dusky-brown, $9\text{--}15.5\ \mu \times 4\text{--}6\ \mu$, borne on filamentous, simple, hyaline to dilutely-colored sporophores which measure about $20\text{--}45 \times 0.75\ \mu$.

On culm of *Zea Mays* L.

Type specimen: Mattoon, Coles County, Illinois. October 19, 1926. Nat. Hist. Surv. Acc. No. 20039.

Collected only once.

The parasitism of this fungus is doubtful.

***Phyllosticta Zeae* n. sp.**

Spots at first ellipsoid, becoming elongated and irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan-colored, their margins brownish to fading, their interior finally becoming cinereous. Pycnidia located in the mesophyll, often in rows between and sometimes appressed to the microscopic leaf veins (vascular strands), opening epiphyllously or hypophyllously by a minutely-papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose or flattened-globose, $60\text{--}150\ \mu$ in diameter; ostiole rounded, $12\text{--}26\ \mu$ across, the ostiolar papillum appearing darker than the wall of the pycnidial body. Spores one-celled, hyaline, ovoid to ellipsoid, $4.5\text{--}7.5 \times 2\text{--}3.5\ \mu$. (PLATE 24, FIG. 8.)

On leaf of *Zea Mays* L.

Type specimen: Robinson, Crawford County, Illinois. November 5, 1926. Nat. Hist. Surv. Acc. No. 19359.

Duquoin, Perry County, Illinois. October 8, 1927. Nat. Hist. Surv. Acc. No. 21196. Spores emerged in a distinct cirrus and

seemed to be held together by a gelatinous or mucilaginous hyaline substance.

Mattoon, Coles County, Illinois. September 15, 1927. Nat. Hist. Surv. Acc. No. 21165. On same slide from same spot was *Mycosphaerella zeicola*.

In various specimens of this species other than the type, the spores were seen to emerge from the pycnidium in a distinct cirrus.

Collected 50 times and in 43 counties widely distributed throughout the State. Probably present in all counties.

No species of this genus has been described as occurring on corn, but two species of *Phoma* have been reported from which this fungus may be distinguished as follows:

Spores cylindrical, $4-6 \times 1.5-2 \mu$	<i>Phoma Maydis</i>
Spores fusoid-oblong to oblong-ellipsoid, $4.5-5.5 \times 1.5 \mu$, pycnidia $80-100 \mu$	<i>Phoma zeicola</i>
Spores ovoid to ellipsoid, $4.5-7.5 \times 2-3.5 \mu$, pycnidia $60-150 \mu$	<i>Phyllosticta Zeae</i>

Physalospora Zeae n. sp.

Follicolous; perithecia located in the mesophyll, opening by a minutely-papillate ostiole, externally carbonous, but microscopically a dark reddish-brown, with a pseudoparenchymatous wall which is continuous with an inner structure of hyaline pycnosclerotial pseudoparenchyma enclosing the hymenium and from which the latter appears to arise, globose, $75-235 \mu$ in diameter; ostiole rounded, $12-30 \mu$ across. Asci cylindrical, straight to curved, stalked, double-walled, a tiny pore sometimes apparent at the apex, the inner wall fitting closely to the spore column, the outer wall thickened, especially at the apex, and colorless so as to be seen with difficulty except for its obscure outer boundary, $85-150 \times 13-22 \mu$. Paraphyses obscure, hyaline, filamentous. Spores eight per ascus, arranged subbiserially, hyaline to very dilute olivaceous, one-celled, narrow-ellipsoid, often tapering to narrow, rounded ends, sometimes presenting one flattened and one curved side, $19-25 \times 6.5-8 \mu$. (PLATE 24, FIGS. 9-10.)

On leaves of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. 19883.

On the same leaf with this specimen was *Macrophoma Zeae*, Tehon & Daniels, Nat. Hist. Surv. Acc. No. 19882, and a pycnosclerotial form which may be described as follows: pycnosclero-

tia very abundant, densely spread over a large elongated dead area of the leaf, separate, globose, 100–225 μ in diameter, located in the mesophyll, usually adjacent to and often slightly flattened against the inner surface of the upper or lower epidermis, finally opening either epiphyllously or hypophyllously by a minutely papillate ostiole, externally carbonous, in section composed of a dark, reddish-brown, pseudoparenchymatous wall continuous with a hyaline pseudoparenchyma which fills the interior, the latter sometimes appearing to histolyze and result in the formation of what appear to be irregularly globose or angular free cells or cell fragments; ostiole rounded, about 25 μ across.

This pycnosclerotial form was again found intimately associated on the same leaf with *Macrophoma Zeae* (Hamel, Madison County, November 15, 1926. Nat. Hist. Surv. Acc. No. 19941) and an immature ascomycete which gave evidence of being *Physalospora Zeae*, although none of its asci were found to be mature enough to furnish spores so that it might be identified with certainty.

It was possible to observe in various young perithecia of this ascomycete a pycnosclerotium-like interior within which young asci were found in various stages of development. This fact, coupled with the constant intimate association of the pycnosclerotia and perithecia in the same area on the leaf in that specimen and the pycnosclerotial character of the inner wall of the perithecia, as noted in the description of *Physalospora Zeae* above, with the accompanying association there also of the two forms (pycnosclerotia and perithecia), tends to suggest that possibly the pycnosclerotia are simply a younger stage in the development of the perithecium.

Further, the equally constant and intimate association of *Macrophoma Zeae* in both instances above might tend to suggest the *Macrophoma* as a pycnidial stage in the *Physalospora*. We, of course, do not know that the pycnidia of the *Macrophoma* and the perithecia of the *Physalospora* do not both develop through the pycnosclerotial stage.

Associated with *Macrophoma Zeae* in a specimen from Paris, Edgar County, Illinois, November 4, 1926, Nat. Hist. Surv. Acc. No. 21236, was an ascomycete not sufficiently matured to bear

spores, but which bore all other evidence of being *Physalospora Zeae*.

Physalospora Zeae differs from *Physalospora zeicola* Ellis and Ev. by its much larger asci and by its longer but narrower spores.

***Pleosphaerulina zeicola* n. sp.**

Spot elongate and extensive, rather irregular, more or less laterally bounded by the leaf veins, its margin brownish to fading, broad and not well defined, and its interior grayish-tan-colored. Perithecia not abundant, grouped in a tiny patch, located in the lower mesophyll, opening hypophyllously through a minutely papillate ostiole, brown, membranous, composed of a pseudo-parenchyma, flattened-globose, $100\text{--}150\ \mu$ in diameter; ostiole rounded, $35\text{--}50\ \mu$ across, the ostiolar papillum appearing darker than the perithecial body and presenting the appearance of a ring when viewed from above. Asci ovate to saccate, apparently without stipe, their walls hyaline and often thickened toward one end of the ascus, $56\text{--}73 \times 33\text{--}43\ \mu$. Spores eight per ascus, hyaline, muriform, subellipsoid to suboblong, broader toward one end, transversely 3- to 5-septate and longitudinally 1- to 2-septate, often constricted at the septa, $8\text{--}15 \times 26\text{--}38\ \mu$. (PLATE 24, FIG. 11.)

On leaf of *Zea Mays* L.

Type specimen: Highland, Madison County, Illinois. October 26, 1927. Nat. Hist. Surv. Acc. No. 21182.

Collected only once.

Associated with this form and covering the entire spot was a fungus that showed signs, by its undeveloped conidiophores and general appearance, of being an *Alternaria*, a *Macrosporium*, or a *Helminthosporium*, but it was too immature to produce spores so that it might be identified. It seems possible that this might be an imperfect condition of the *Pleosphaerulina*.

***Septoria Zeae* n. sp.**

Spots at first ellipsoidal, becoming elongated and somewhat irregular, the leaf veins tending to bound them laterally, their margins dark and then marked to fading, their interior becoming tan-cinereous. Pycnidia located in the mesophyll, opening by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, $90\text{--}130\ \mu$ in diameter; ostiole rounded, $11\text{--}22\ \mu$ across, the ostiolar papillum appearing much darker than the pycnidial body. Spores often adhering in

bundles of two or more after leaving the pycnidium, at maturity usually seven- (rarely eight-) septate, sometimes slightly constricted at the septa, the cells usually longer than the width of the spore, the end cells elongate and particularly the basal cell often with attenuated color, nearly hyaline to very dilute greenish-yellow, cylindrical, tapering slightly to one or both rounded ends, straight to variously slightly curved, $25-62 \times 2.5-4 \mu$. (PLATE 24, FIG. 13.)

On leaf of *Zea Mays* L.

Type specimen: Joliet, Will County, Illinois. September 24, 1926. Nat. Hist. Surv. Acc. No. 19673.

Dixon, Lee County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. 19681. The spores in this specimen were somewhat more constricted at the septa and larger than in the type, measuring $40-77 \times 2.5-5.5 \mu$ and ranging up to fourteen-septate in some cases.

Elgin, Kane County, Illinois. September 24, 1926. Nat. Hist. Surv. Acc. No. 19725. Perithecia up to 150μ in diameter, spores up to nine-septate and measuring up to $62 \times 4.5 \mu$. This specimen was associated in the same spot and appeared on the same slide with *Leptosphaeria Maydis*, Nat. Hist. Surv. Acc. No. 19725.

Moline, Rock Island County, Illinois. October 8, 1926. Nat. Hist. Surv. Acc. No. 19716. Associated on same spot and slide with *Leptosphaeria Maydis*, Nat. Hist. Surv. Acc. No. 19716.

Mount Carroll, Carroll County. September 27, 1926. Nat. Hist. Surv. Acc. No. 19682. Spores often markedly constricted, up to ten-septate, measuring $40-66 \times 3-4.5 \mu$. Pycnidia somewhat larger than in the type, measuring up to 150μ in diameter.

Rockford, Winnebago County, Illinois. September 25, 1926. Nat. Hist. Surv. Acc. No. 19677. Pycnidia measured up to 150μ in diameter.

Stockton, Jo Daviess County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. 19683. Spores often markedly constricted at the septa, up to nine-septate, measuring up to $66 \times 5.5 \mu$.

Streator, La Salle County, Illinois. September 23, 1926. Nat. Hist. Surv. Acc. No. 20100. Pycnidia up to 150μ . Associated on same spot and same slide with *Leptosphaeria Maydis*,

Nat. Hist. Surv. Acc. No. 19671. On the same host leaf was also found *Phyllosticta Zeae*.

Collected 11 times and in 11 counties scattered over the northern three-fifths of the State.

***Septoria zeicola* n. sp.**

Spots at first ellipsoid, becoming elongated and somewhat irregular, the leaf veins tending to bound them laterally, their margins brownish to fading, their interior becoming cinereous. Pycnidia located in the mesophyll, opening either epiphyllously or hypophyllously by a minutely-papillate ostiole, brown, membranous, composed of a pseudoparenchyma, flattened-globose or lenticular, 55–135 μ in diameter; ostiole rounded, 10–15 μ across, the ostiolar papillum sometimes appearing darker than the wall of the pycnidial body. Spores one- to four- (usually three-) septate, nearly hyaline to a very dilute greenish-yellow, cylindrical, tapering to one or both rounded ends, straight to variously slightly curved, 18–38 \times 2.5–3.5 μ . (PLATE 24, FIG. 14.)

On leaf of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. 20102.

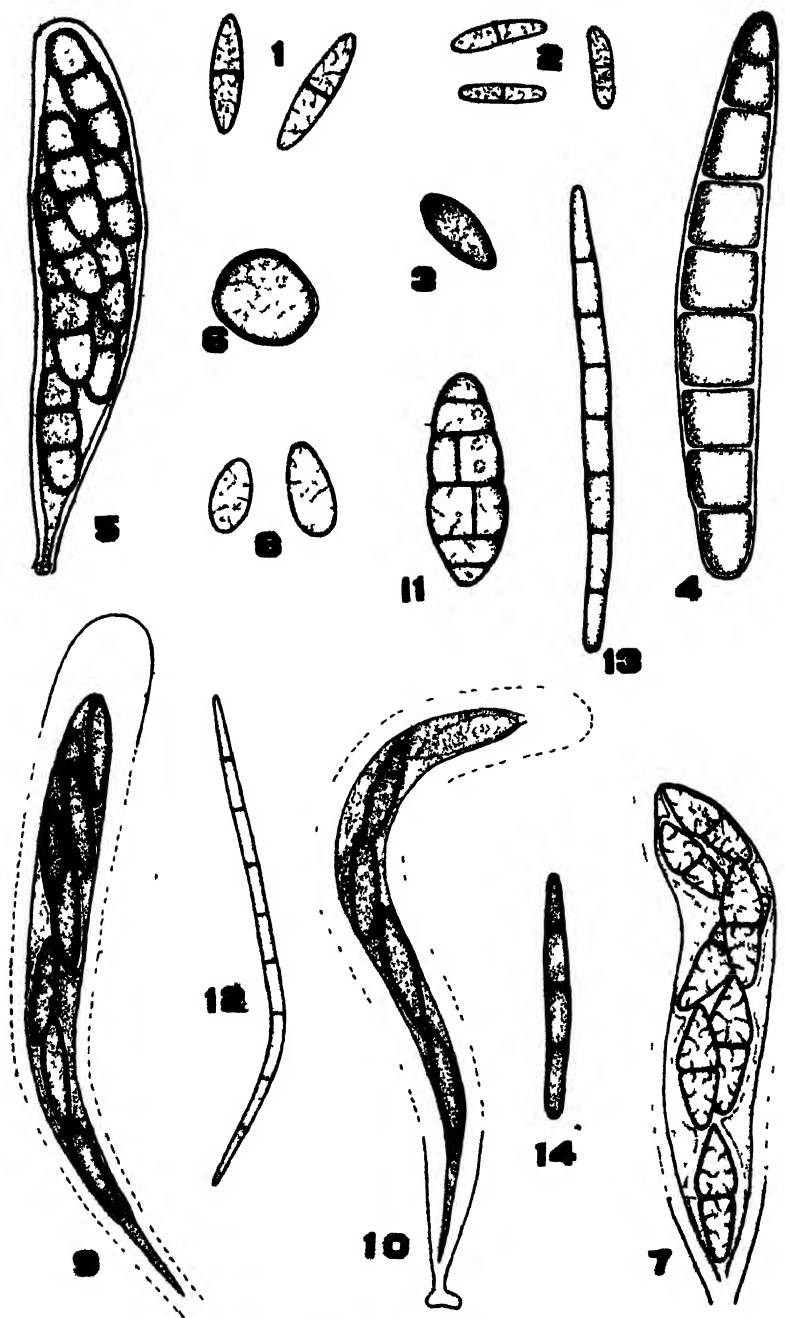
Casey, Clark County, Illinois. October 24, 1927. Nat. Hist. Surv. Acc. No. 21160. The spores here were somewhat larger than in the type, measuring up to 46 \times 3.5 μ , occasionally with as many as five septa, and sometimes very slightly constricted at the latter.

Harrisburg, Saline County, Illinois. October 10, 1927. Nat. Hist. Surv. Acc. No. 21211. Spores measured up to 40 μ long.

McLeansboro, Hamilton County, Illinois. November 10, 1926. Nat. Hist. Surv. Acc. No. 20136. Associated in the same spot and appearing on the same slide with this specimen were *Mycosphaerella Zeae* and *Phyllosticta Zeae*.

Mattoon, Coles County, Illinois. September 15, 1927. Nat. Hist. Surv. Acc. No. 21162. Spores somewhat shorter than in the type, usually 20–23 μ long, but ranging from 16–27 μ , and one- to three-septate, never more than three septa seen.

Toulon, Stark County, Illinois. October 7, 1926. Nat. Hist. Surv. Acc. No. 20138. Here the spores were somewhat larger than in the type, measuring up to 42 \times 3.5 μ , and sometimes somewhat constricted at the septa.



FUNGI OF INDIAN CORN

West City, Franklin County, Illinois. November 12, 1926. Nat. Hist. Surv. Acc. No. 19629. Associated in the same spot and on the same slide with *Mycosphaerella Zeae* and *Phyllosticta Zeae* and recorded under above number with *Mycosphaerella Zeae*.

Collected 16 times and in 16 counties well distributed over the State.

***Septoria zeina* n. sp.**

Spot narrow-elongate, laterally bound by the leaf veins, cinereous, papery, somewhat translucent by transmitted light, without a well defined margin. Pycnidia subepidermal, opening epiphyllously by a minutely-papillate ostiole, brown, membranous, obscurely pseudoparenchymatous, flattened-globose to lenticular, 66–200 μ in diameter; ostiole rounded, 12–30 μ across, the ostiolar papillum appearing much darker than the wall of the pycnidial body. Spores filamentous, tapering at both ends to a rounded point, variously curved, obscurely many-septate but the septa (commonly eight) not always apparent, nearly hyaline or very dilute greenish-yellow, $50\text{--}90 \times 2\text{--}2.5 \mu$, sometimes reaching 100 μ in length. (PLATE 24, FIG. 12.)

On leaf of *Zea Mays* L.

Type specimen: Taylorville, Christian County, Illinois. October 20, 1927. Nat. Hist. Surv. Acc. No. 21231.

Septoria Maydis Schulz differs from this species and the two preceding by its smaller spores, $20\text{--}22 \times 2 \mu$.

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EXPLANATION OF PLATE 24

1. Spores of *Ascochyta Maydis*; 2. Spores of *Ascochyta Zeae*; 3. Spore of *Coniothyrium Zeae*; 4. Spore of *Helminthosporium zeicola*; 5. Ascus and spores of *Leptosphaeria Zeae*; 6. Spore of *Leptothyrium Zeae*; 7. Ascus of *Mycosphaerella zeicola* containing seven spores (the usual number is eight); 8. Spores of *Phyllosticta Zeae*; 9. Ascus of *Physalospora Zeae* containing four perfectly formed spores and, in the upper end, one that was imperfectly formed; 11. Spore of *Pleosphaerulina zeicola*; 12. Spore of *Septoria zeina*; 13. Spore of *Septoria Zeae*; 14. Spore of *Septoria zeicola*.

ON THE RESISTANCE OF *NEUROSPORA CRASSA*

ANNA F. FAULL

(WITH 1 TEXT FIGURE)

The red bread-mould fungi of the *Monilia* (*Neurospora*) group, and especially *M. sitophila*, have been for many years the subjects of various lines of investigation. The recent work of B. O. Dodge (1, 2, 3, etc.) and others has demonstrated heterothallism in two of the species, established a perfect ascomycetous phase and brought out other points of interest in sexuality and hybridization in the group. Earlier work emphasized the harmful growth of these fungi in various foods, their wide distribution and occurrence in burned-over areas. Moreover, some attention has been paid to the resistance of the spores to heat and intense light. In the hope that further points on the development and resistance of *Neurospora crassa*, a species closely related to *N. sitophila*, may be of interest in this connection, the following note is presented.

The source of the material discussed here was a profuse growth of the mould which Professor W. H. Weston encountered on burned stumps of *Dichrostachys nutans* at Colonia Palmarito, Central Trinidad, Santa Clara Province, Cuba, on August 30, 1925, and from which a moulded fragment was brought back. This specimen, in March, 1928, after being kept in a herbarium packet for nearly three years, was revived in a sterile, damp chamber and from it were derived the cultures used in the following study.

GROWTH IN CULTURE

For the first gross cultures, which supplied most of the perithecial and a part of the conidial material used in the experiments and from which the pure cultures supplying the rest of the material were derived, the original fragment of *Dichrostachys* was broken into three pieces, each of which was placed in a sterile, damp chamber. Within ten days, fluffy orange-pink masses of

conidiophores and mycelium appeared covering the sticks and the sides of the chamber, even growing through the sphagnum used to keep the culture moist, while two weeks later perithecia formed in the third of these cultures and the two pure cultures on cornmeal agar taken from it. The perfect form in the gross culture when it grew on the surface near the side of the dish discharged its spores freely, but when it grew below the surface between the damp sphagnum and the glass of the container was unable to shoot out the spores which remained in dark masses after the perithecia had disintegrated. In this one culture, the perfect form developed almost entirely on the portions of the chamber least exposed to light such as the bottom of the dish and the sides turned away from the nearest window.

Pure cultures, which were examined daily for two or three months, were made from the gross cultures by transferring with a sterile needle a few conidia from them to the surface of sterile media in closed containers. Within twenty-four hours, a fine network of mycelium and a fringe of orange-pink conidiophores appeared which in succeeding days developed more abundantly, until in some cases, and especially on Sabouraud agar in test-tubes, the whole tube was filled with a cottony mass of brownish mycelium and conidiophores. When the perfect stage developed in several of the cornmeal agar cultures taken from the third gross culture, the perithecia appeared in ten days or two weeks after inoculation in brown masses on the surface of the agar and the sides of the tube where they discharged ascospores onto the opposite surfaces on which they accumulated as a black powder. In the other cultures on cornmeal agar in ten days or two weeks after inoculation instead of perithecia there appeared on the surface brown dots which proved on examination to be bulbils of many-septate contorted hyphae similar to those described by Shear and Dodge (4) and by Tokugawa and Emoto (5). These later developed into dark sclerotial masses.

Under optimum conditions, a luxuriant growth of solid masses of mycelium and conidiophores developed, even in some instances spreading far out over non-nutrient surfaces. In the case of a chance contamination of a pot of radish seedlings, conidiophores formed a red turf across the surface of the soil and the mycelium

followed bits of wood through the humus to the bottom of the pot, for conidia formed there were shed through the hole onto the table. Moreover, on bread in an evaporating dish, equally dense mats of mycelium and conidiophores formed which even grew over the non-nutrient glass to half-way across the cover of the container. But under adverse conditions on prune agar or on very wet bread, there was no appreciable growth, while under less adverse conditions, such as were encountered in cultures on nutrient agar in petri dishes where enough moisture may not have been retained, growth was scanty and, although conidia formed normally, the perithecia dried up before they could produce spores.

For study and experimental work, to supplement the gross culture material, the pure cultures on cornmeal agar in test-tubes were used because here a loose fringe of conidiophores formed, leaving a bare surface of agar for the development of perithecia and bulbils.

IDENTIFICATION

The fungus was identified by Dr. B. O. Dodge from dried material and slides as *Neurospora crassa* Shear and Dodge. The conidia, measuring 2.9–13.4 μ in diameter in this material, were often larger than is usual for the species, frequently 8.6 μ and almost as often 11.4 μ in diameter instead of the range of 6–8 μ , usually 6–7 μ , described for the type material by Shear and Dodge (4). But measurements of ascospores which were 20.0–33.0 \times 14.3–20.0 μ , mostly 25.7 \times 14.3 μ , of asci which were 140.0–170.0 \times 14.0–17.0 μ , and of perithecia which were 280.0–500.0 μ in diameter were those described by Shear and Dodge (4) for *N. crassa*. In this material, the characteristic longitudinal markings on the ascospores were indistinct in freshly formed material but became more distinct later in both dried and mounted material.

STRUCTURE AND DEVELOPMENT

Several observations^{8, 11} made earlier it seems worth while to emphasize here since they were also characteristic of this material. Shear and Dodge (4) have already demonstrated heterothallism and mentioned as characteristic the formation of bulbils in cul-

tures where only one strain is present. Also in some cases in these cultures there were abnormally large ascospores, even as large as $40 \times 20 \mu$, described by Dodge (1) as forming where two or more nuclei instead of one are involved in cutting out the ascospore. Shear and Dodge (4) also described as characteristic of the genus germination of the spores by germ tubes from both ends, although in a few cases in this material only one of the germ tubes formed.

Three points not emphasized in the literature may be noted here, namely the time for germination of unheated ascospores, the effect of light on the imperfect stage and the nature of the "ridges" on the ascospore wall. In these tests¹ the ascospores germinated in three to four hours when finally left at room temperature except when the spores were heated and germination was delayed, in which case, as may be seen in the table, page 298, the spores required the four to five hour resting period noted by Shear and Dodge (4) or in some cases an even longer one. The imperfect stage when allowed to grow in daylight showed itself positively heliotropic, for the mats of mycelium and conidiophores would form on the sides of the containers most exposed to light and, when the dish was moved, on the side thus turned towards the light. The markings on the ascospores, moreover, seemed not to be "ridges" but lighter differentiated parts of the cell wall. The smooth outline of the spore, the absence of shadows from the "ridges" even with oblique lighting, the increase in distinctness of the lines in spores mounted for several months in balsam and, finally, the even thickness of the cell wall with no indication of "ridges" in fragments of wall broken across the lines and turned upward are proof of this (FIG. 1, C, D AND E').

EXPERIMENTS ON THE GENERAL RESISTANCE OF

Neurospora crassa

As the assumption of the thermophilic character of *Monilia* (*Neurospora*), and especially of *M. sitophila* to which *N. crassa* is very closely allied, is often found in the literature with especial emphasis on the widespread and profuse occurrence of these

¹ Since these experiments were performed this observation has been noted by B. O. Dodge in his article, "Breeding Albinistic Strains of the *Monilia* Bread Mold," in MYCOLOGIA, Vol. 22, No. 1, January-February, 1930.

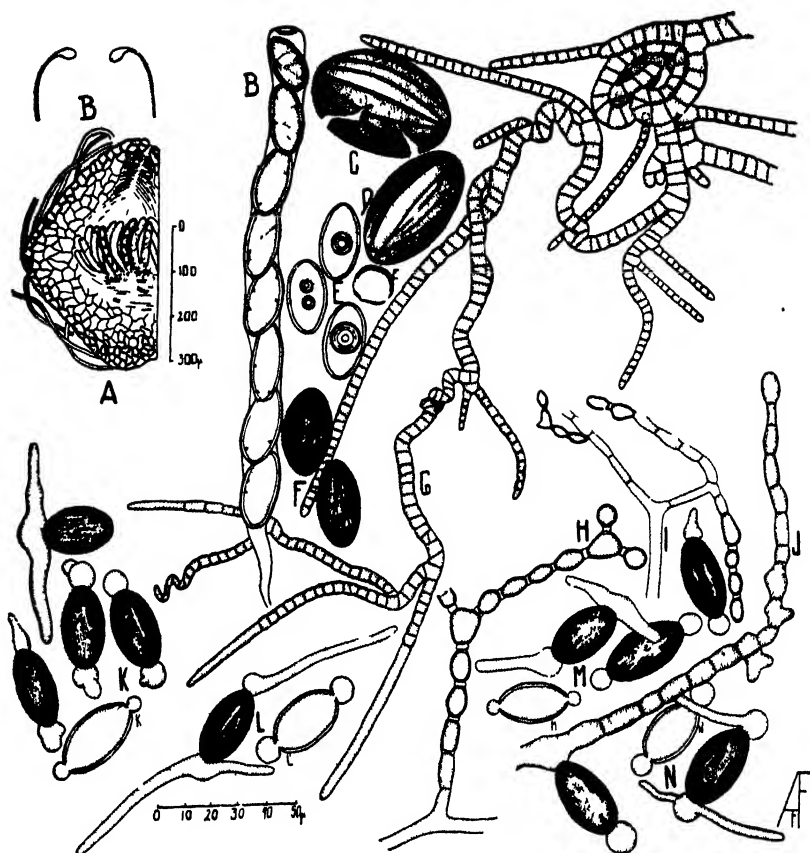


FIG. 1. These drawings of *Neurospora (Monilia) crassa* were made with a camera lucida. The magnifications given are for the printed plate, the scale of microns giving an absolute measure also.

A. Ideal median longitudinal section of half a perithecium showing the lysigenous cavity with some septate hyphae and immature asci. Section cut free hand from fresh gross culture material and mounted in Am nn's medium, $\times 47$; B. Mature ascus characteristic of the genus showing cylindrical, short-stipitate form, terminal pore, gelatinous apical ring and uniseriate staggered arrangement of the eight spores almost filling the ascus. From fresh, gross culture material mounted in water; B'. Tip of ascus described in B showing enlarged gelatinous apical ring in optical section; C. Empty ascospore coat showing characteristic longitudinal marking. From gross culture material cleared in xylol, dried on slide and mounted in balsam, $\times 777$; D. Mature ascospore under oblique illumination showing markings in surface view. From same slide as C, $\times 738$; E. Mature ascospores in optical section showing large oil drops and terminal pores in the thick wall. From gross culture material mounted in water; E'. Fragment of ascospore wall in cross section showing

species in burned areas and with the deduction that heat is necessary for successful growth, the question arose as to whether or not this association with heat in the tropics, in fire-swept regions or after unusual heating was the manifestation of a general resistance which might also be demonstrated under other adverse conditions such as extreme cold. An attempt, therefore, to determine (1) whether heat was necessary for development and (2) whether the fungus was equally resistant to low as well as to high temperatures was made through three sets of experiments: a first one in which the spores were heated to test the resistance to an abnormally high temperature, a second at room temperature to show the development at a moderate temperature without the introduction of heat and a third at low temperatures to discover the effect of extreme cold on the fungus.

The material used for these tests, both ascospores and conidia, was taken directly from the gross and pure cultures or, in the case of some of the ascospores, from perithecia from the same source

differentiation in composition of cell wall which in surface view gives somewhat the appearance of ridges. Included through the courtesy of Dr. B. O. Dodge and drawn from a slide lent by him; *F.* Mature ascospores in surface view showing here and there the markings that are not discernible under all conditions and the oil globules as seen through the wall. From material in Van Tieghem cell with cornmeal agar drop and drawn in place; *G.* Immature bulbil showing contorted many-septate hyphae formed at room temperature in Van Tieghem cell with cornmeal agar drop. Drawn in place; *H.* Conidiophore of normal type growing in Van Tieghem cell with cornmeal agar drop. (Conidiophores often larger and more branched); *I.* Conidiophore formed in ampule above water from spores germinating after being exposed to -79° C. for several hours. Compare normal structural and proportional features of branching, thickness of spore wall and the isthmus between every two spores with the normal conidiophore in *H*; *J.* "Conidiophore" formed in the same ampule described in *I* but under water. Compare short mycelial growth broken by cross walls into *Oidium*-like cells with unmodified walls and no connecting isthmi with normal type in *H* and *I*; *K.* Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop to which they were transferred from the gross culture; *L.* Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop after being exposed to -170° – -190° C. for fourteen hours; *M.* Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop after being exposed to $-37\frac{1}{2}^{\circ}$ C. for one hour; *N.* Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop after being exposed to -79° C. for twelve hours; *K', L', M', N'.* Ideal optical sections through ascospores described in *K, L, M* and *N* showing contents of spores swelling out through the spores as they germinate. Except where otherwise indicated magnification is $\times 387$.

that were kept dried in pill boxes for one or two months. Controls for both wet and dry spores for all experiments were kept at room temperature to be placed on cornmeal agar drops in Van Tieghem cells when the heated or cooled spores were returned to this temperature and placed in similar cells. All the spores were kept under observation for several days after being placed in the cells during which time notes were taken on the time elapsing before germination of the first spores and on the percentage of spores that had germinated within the succeeding few hours. The percentage of germinating spores for each Van Tieghem cell was found by adding counts up to one or three hundred of all the spores in random fields. The significant results are tabulated on page 298.

In the first experiment on high temperatures, only ascospores were used and these were heated in a temperature oven to $51\frac{1}{2}^{\circ}$ C. for varying lengths of time. Some were put in pill boxes to be heated dry while others were transferred with a sterile needle to the surface of a cornmeal agar drop in a Van Tieghem cell to be heated in a moist condition. Some of the spores were removed to cornmeal agar drops in Van Tieghem cells at room temperature after being slowly heated to $51\frac{1}{2}^{\circ}$ C., but the others were left at this temperature for from one to four hours. The results as given in the table on page 298 agreed with earlier notes throughout the literature that the ascospores are resistant to heat. They also showed that germination was delayed for from one to fifteen hours after the spores had been heated in a moist condition to a temperature as high as $51\frac{1}{2}^{\circ}$ C. for an hour or more although spores heated dry to the same temperature for the same length of time showed a delay in germination of only three hours or less. The percentage of germinating spores in this test calculated at intervals of from one to eighteen hours after germination of the first spores ranged from five to ninety-four per cent.

In the second experiment, again ascospores alone were used; only in this instance they were put in Van Tieghem cells at room temperature, 27° C., without previous heating or cooling. They germinated within three or four hours, apparently the normal type of germination. The percentage of germinating spores, four to twenty-five, calculated within three or four hours after germi-

nation of the first spores, although lower than in the first experiment where the spores were allowed a much longer period of growth after germination of the first spores, is sufficient to indicate that heating is not necessary for germination of the spores.

In the third experiment, both ascospores and conidia were used, but they were subjected to four different low temperatures for varying periods. The first low temperature of 0°C . was obtained (for ascospores only) by placing them in the ice compartment of a Frigidaire cooler. To do this, the spores were placed dry in small vials or transferred to hanging drops of cornmeal agar in Van Tieghem cells which were then supported with paper in the ice pan of the cooler, covered with water and frozen. Cells and vials were removed at intervals of from several hours to eighty-two days to room temperature where the spores were kept in Van Tieghem cells for several days under observation. In every case, germination occurred within three or four hours after removal from the refrigerator. The second low temperature of $-37\frac{1}{2}^{\circ}\text{C}$. was obtained for both ascospores and conidia by using a mixture of sulphuric acid and ice. The spores, dry or in water, were placed in ampules made from pieces of glass tubing eight to ten centimeters long which, when sealed, were lowered into the cooling mixture of equal volumes of *dry* scraped ice or snow and a fifteen per cent by volume dilution of sulphuric acid. Since it was hard to obtain this temperature or to keep it for more than an hour, the data were scanty, but normal germination of both ascospores and conidia was recorded in every case when the spores were returned to room temperature at the end of an hour. The third low temperature of -79°C . was obtained for both types of spores by using solid carbon dioxide. As before, the spores, both dry and in water, were placed in ampules in the cooling substance of solid "snow" collected by holding tightly a canvas bag six inches square over the escape valve of a tilted tank of commercial liquid carbon dioxide and then packing it in an open-mouthed Dewar flask which in turn was packed in waste cotton. From time to time the ampules were removed and the spores transferred to Van Tieghem cells at room temperature where they germinated normally in almost every case. Since this temperature was easy to obtain and keep, abundant data were

gathered. The fourth low temperature of -170° to -190° C. was obtained for both types of spores by using liquid air. The spores, both dry and in water, were placed in ampules as before, but this time the ampules were provided with a loop at one end to which a thread was tied before they were lowered into the liquid air. At intervals of from one minute to forty-eight hours ampules of spores were removed to room temperature where they remained under observation for several days. In almost every case, the ascospores germinated normally, even when subjected to this temperature for as long as twenty-four hours when wet and as long as forty-eight hours when dry, and the dry conidia did likewise after one hour's exposure, but the conidia that had been wet were killed by as little as five minutes' exposure. Since in the third set of experiments the germination occurred as in the second at the end of three hours and with percentages of germinating spores varying from one to ninety-one, the resistance of these spores to extreme cold was demonstrated and also the fact that heating was unnecessary for germination, as found in the second experiment, was borne out.

In brief, these experiments show that *Neurospora crassa* is not a thermophile but a very resistant form with ascospores able to withstand temperatures as high as 50° C. for four hours and as low as -170° to -190° C. for long periods and with conidia only somewhat less resistant to extremes. They also demonstrate that for germination the ascospores do not necessarily require heating above room temperature, although Shear and Dodge (4) have found that heating the oven in which petri dishes of ascospores on nutrient agar have been placed to 90° C. for a short time increases the number of germinating spores and is useful in obtaining single spore cultures by the "plating out" method.

Further proof of the general hardiness of this fungus was encountered during these experiments through a chance observation on some spores that after being cooled to -79° C. for an hour or more were left on the table in an unopened ampule for two days before growth was noticed. Although the ascospores were submerged in water where there would be little air, confined in an ampule which would restrict the supply of gases to one or two cubic centimeters and left with no food except what might be in

the water and in bits of debris that clung to them when they were placed in the ampule, they had germinated normally to produce mycelium and conidiophores. Examination showed that two types of spores had formed, first, normal but stunted conidiophores (FIG. 1, *I*) above the surface of the water and, second, *Oidia*-like spores (FIG. 1, *J*) formed beneath the water by the cutting up of the mycelium by cross walls into short cells with thin walls and no connecting isthmus in contrast to the thick walls and connecting isthmus of normal conidia (FIG. 1, *H*). That any growth should occur under these conditions and, moreover, that spores should form is still another instance of the remarkable hardness of the *Monilia* (*Neurospora*) group and in this case of *N. crassa*.

EXPLANATION OF TABLE

Conidia used in experiments were obtained from tube cultures and transferred directly to ampules or Van Tieghem cells.

Ascospores were obtained from gross cultures or tubes by crushing perithecia or by scraping spores from the side of the tube where they had been shot or by picking out masses of perithecia and spores formed between the sides of the container and the sphagnum. They were transferred directly to ampules or Van Tieghem cells or kept dry in pill boxes for a month or so until needed.

The following numbers of Van Tieghem cells were used in the various experiments:

At 51½° C. 2 V.T. cells were used for each temperature wet and for each temperature dry besides 2 controls.

At 27½°–30° C. 8 V.T. cells were used.

At 10°–12° C. 8 V.T. cells were used.

At 0° C. 4 V.T. cells were used.

At – 37½° C. several V.T. cells were used besides the controls.

At – 79° C. 17 V.T. cells were used for the ascospores besides 5 controls.

In these germination failed to occur in 4, 1 a control. 10 V.T. cells were used for conidia besides 2 controls. Germination failed to occur in 3, 1 a control.

At – 170° to – 190° C. 18 V.T. cells were used for ascospores besides 4 controls.

9 V. T. cells were used for conidia besides 4 controls. In these all the wet conidia except the controls failed to germinate but the dry conidia germinated normally.

† Spores were exposed in Van Tieghem cells.

†† Spores were at that temperature from time they were shot from the ascus.

* Time of germination was calculated by comparison of length of mycelium when observed with length of mycelium where period of growth for given development of spore was known.

** "germ." represents germination of an appreciable number of spores, one to ninety-four per cent. The actual percentages are not included here because the periods elapsing between the germination of the first spores and the calculating of the percentage germination for each cell were not comparable.

RESULTS OF EXPERIMENTS ON EFFECT OF TEMPERATURE ON SPORES OF *Neurospora crassa*

# Kind of Spore	Temperature ° C. to Which Spores Were Exposed	Time of Exposure	Condition of Spores	Germinated or Not	Time after Exposure to Germination of First Spores
Ascospores	25.5°	Control	Wet	**Germ.	3 hrs. 15 min.
"	51.5°	0 hrs. 1 min.	Wet	**Germ.	3 hrs. 27 min.
"	"	0 hrs. 1 min.	Dry	**Germ.	3 hrs. 27 min.
"	"	1 hr. 20 min.	Wet	**Germ.	*8 hrs. 8 min.
"	"	1 hr. 20 min.	Dry	**Germ.	*7 hrs. 36 min.
"	"	2 hrs. 38 min.	Wet	**Germ.	*6 hrs. 0 min.
"	"	2 hrs. 38 min.	Dry	**Germ.	*6 hrs. 20 min.
"	"	3 hrs. 20 min.	Wet	**Germ.	*18 hrs. 15 min.
"	"	3 hrs. 20 min.	Dry	**Germ.	*5 hrs. 45 min.
"	"	4 hrs. 8 min.	Wet	**Germ.	*17 hrs. 15 min.
"	"	4 hrs. 8 min.	Dry	**Germ.	*4 hrs. 45 min.
Ascospores	27.5°-30°	†† ††	Wet Wet	**Germ. **Germ.	3 hrs. 0 min. 4 hrs. 10 min.
Ascospores	†10°-12°	24 hrs. 0 min. 60 hrs. 15 min. 82 days	Wet Wet Wet	**Germ. **Germ. **Germ.	3 hrs. 30 min. 2 hrs. 15 min.
Ascospores	27.5° -37.5°	Control 0 hrs. 13 min. 0 hrs. 45 min.	Wet Wet Wet	**Germ. **Germ. **Germ.	3 hrs. 3 hrs. 3 hrs.
Ascospores	27.5°	Control	Wet	**Germ.	3 hrs.
"	"	0 hrs. 7 min.	Wet	Not	
"	-79°	1 hr. 45 min.	Wet	**Germ.	3 hrs.
"	"	1 hr. 0 min.	Wet	**Germ.	3 hrs.
"	"	3 hrs. 0 min.	Wet	Not	
"	"	72 hrs. 0 min.	Wet	Not	
"	"	72 hrs. 0 min.	Wet	**Germ.	3 hrs.
"	"	48 hrs. 0 min.	Wet	**Germ.	3 hrs.

RESULTS OF EXPERIMENTS ON EFFECT OF TEMPERATURE ON SPORES OF *Neurospora crassa*—Continued

Kind of Spore	Temperature ° C. to Which Spores Were Exposed	Time of Exposure	Condition of Spores	Germinated or Not	Time after Exposure to Germination of First Spores
Ascospores	27.5°	Control	Wet	**Germ.	3 hrs.
	"	0 hrs. 5 min.	Dry	**Germ.	3 hrs.
	-170° to -190°	0 hrs. 5 min.	Wet	**Germ.	3 hrs.
	"	0 hrs. 10 min.	Wet	Not	
	"	1 hr. 0 min.	Dry	**Germ.	3 hrs.
	"	1 hr. 0 min.	Dry	**Germ.	3 hrs.
	"	20 hrs. 0 min.	Wet	**Germ.	3 hrs.
	"	24 hrs. 0 min.	Dry	**Germ.	3 hrs.
Conidia	"	48 hrs. 0 min.	Dry	**Germ.	3 hrs.
	-37.5°	0 hrs. 15 min.	Wet	**Germ.	
	"	1 hr. 0 min.	Dry	**Germ.	
Conidia	27.5°	Control	Wet	**Germ.	
	"	0 hrs. 1 min.	Wet	Not	
	-79°	1 hr. 0 min.	Wet	**Germ.	
	"	1 hr. 0 min.	Wet	**Germ.	
	"	1 hr. 0 min.	Wet	Not	
	"	1 hr. 45 min.	Wet	Not	
	"	3 hrs. 0 min.	Dry	**Germ.	
Conidia	27.5°	Control	Wet	**Germ.	
	"	0 hrs. 5 min.	Dry	**Germ.	
	-170° to -190°	1 hr. 0 min.	Wet	Not	
	"	1 hr. 0 min.	Wet	Not	
Conidia	"	1 hr. 0 min.	Dry	**Germ.	

DISCUSSION

The resistance of these fungi to extremes of temperature presents certain points of interest. The ability of these spores to withstand heat and the frequency of growth following conflagrations have been noted so generally that it has come to be assumed that these fungi, and especially *M. sitophila*, are resistant specifically to heat, or especially adapted to growth at relatively high ranges of temperature.

It seemed of possible interest, therefore, to determine whether this material of the closely allied but less studied species, *N. crassa*, that had developed on charred stubs in Cuba following a rather complete brush burning was in reality a thermophile in its temperature relation with a growth optimum at relatively high ranges of temperature and with germination of ascospores and conidia only after being subjected to extremes of heat higher than the usual summer range, or merely a generally hardy fungus resistant to extremes of low as well as of high temperature as it might be to any other unfavorable condition of its environment. The tests which were made, although not sufficiently controlled to yield results of quantitative significance, did furnish qualitative data of some interest.

In these tests, the resistance of *Neurospora crassa* to extreme cold and other unfavorable conditions as well as to extreme heat and its normal development at a moderate temperature, 27° C., have been demonstrated. Although a tropical species that may encounter extremes of heat, it does not meet the extreme cold, - 80° to - 190° C., which the ascospores and conidia survived without injury in the experiments described here. Nor in the tropics would one find long periods of freezing temperatures or even a temperature as low as 0° C. which the ascospores of *N. crassa* endured without injury frozen in blocks of ice for two months. The ascospores were found even more resistant than the conidia, for they could endure temperatures as low as - 170° to - 190° C. for twenty hours when moist or for forty-eight hours when dry and as high as 50° C. for four hours when moist or dry, although heating to 50° C. for more than an hour retarded germination for from three to fifteen hours. The conidia were only somewhat less resistant, surviving temperatures as low as - 170°

to -190°C. for an hour when dry and as low as -80°C. for three hours when moist, although killed at -170° to -190°C. when moist within five minutes. A further instance of resistance was found in the growth of ascospores to produce mycelium and conidia without sufficient food or air after cooling to -79°C.

A consideration of these results shows that this species of the *Monilia* group, *N. crassa*, is a generally resistant fungus that develops normally at a moderate temperature rather than a thermophile with a growth optimum at relatively high ranges of temperature and that this resistance to heat is but one phase of a general hardness. The outstanding instance of this resistance is the ability of the ascospores to withstand temperatures ranging from -190° to 50°C. without injury. The association with heat would seem to be incidental to some other factor in the environment especially suitable for the growth of the fungus such as the production or freeing of specific carbohydrates during the heating of the wood or other substratum.

SUMMARY

Material from Colonia Palmarito, Central Trinidad, Santa Clara Province, Cuba, after being kept dried for nearly three years was revived, cultured and studied under laboratory conditions.

The material used for the experiments was taken from one of the gross cultures and from pure cultures on cornmeal agar because these cultures had a scanty fringe of conidiophores, leaving a bare surface where perithecia and bulbils formed. Perithecia or bulbils developed in ten days or two weeks after the conidiophores appeared. Conidiophores formed in the gross cultures from dried material in ten days, or in the pure cultures within twenty-four hours after inoculation. More or less luxuriant growth occurred in the cultures, depending upon the substratum and the amount of moisture present.

The fungus was identified by Dr. B. O. Dodge as *Neurospora crassa* Shear and Dodge. The conidia were somewhat large for the species but measurements of the ascospores, asci and perithecia which are the distinguishing structures correspond with those described for the type.

Formation of bulbils, heterothallism, occurrence of abnormally

large ascospores and germination of ascospores from both ends were again noted for the species. Three points heretofore less emphasized were noted, namely, (1) that ascospores even when unheated germinate in three to four hours, (2) that the *Monilia* stage is positively heliotropic and (3) that the markings on the walls are not "ridges" but lighter differentiated parts of the wall.

The ascospores were found resistant to 50° C. although with delayed germination when moist and heated for more than one hour, to 0° C. for two months when frozen in blocks of ice with no delay in germination when returned to room temperature, to - 170° to - 190° C. for twenty hours when wet and for forty-eight hours when dry with no delay in germination. They were readily germinated at room temperature in three hours without previous heating. The conidia were found resistant to - 80° C. for one hour when wet and to - 170° to - 190° C. for one hour when dry, although killed at this temperature in five minutes when wet. Ascospores that had been confined in an ampule for several days after cooling to - 80° C. for an hour or more were found to produce mycelium and spores of two types, normal, small conidia on stunted conidiophores above the water and *Oidium*-like spores below the surface.

It is concluded that *Neurospora crassa* is a generally resistant fungus, not a thermophile requiring heat in its development, but resistant to extreme cold as well as to extreme heat and also to other adverse conditions.

In conclusion, I take this opportunity to thank Professor W. H. Weston for supplying the material and for his help throughout the course of the study, Dr. B. O. Dodge for his kindness in identifying the fungus, reading the manuscript and supplying the slide from which the drawing of the cross section of an ascospore was made, and Professor Theodore Lyman for his aid in supplying the liquid air used in the experiments.

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STEMPHYLIUM CONGESTUM AND ITS RELATION TO DECAY IN APPLES

GEORGE D. RUEHLE

(WITH 2 TEXT FIGURES)

Two species of the genus *Stemphylium* have been described as causing a rot of apples. In 1924, Kidd and Beaumont (3) isolated *Stemphylium graminis* (Corda) Bon. from lenticel spots on apples in England, and by means of inoculation experiments proved that this species can be parasitic on apples. In 1928, Newton (4) described a new species, *S. congestum* Newton, as causing a decay of apples in the Pacific Northwest. In addition to these two species, several species of *Pleospora* occurring on apple fruit possess a *Stemphylium-Macrosporium* conidial stage (2, 3, 4). The imperfect stage of these *Pleospora-Stemphylium* species can be readily recognized as distinct from the *Stemphylium* species mentioned above, since when grown on culture media the latter generally produce enormous numbers of conidia in dense botryose clusters, while the former generally produce fewer conidia which are borne singly on the conidiophores. In addition to this difference in conidial formation, the *Pleospora* species readily produce perithecia on culture media, whereas such structures have not been observed in cultures of *S. graminis* or *S. congestum*.

From 1418 isolations from decayed areas on apple fruits from cold storage, the writer isolated twenty-nine cultures of the *S. congestum* type. Most of these cultures were found to be pure in the original isolation plates, but some were mixed with *Pleospora*, *Alternaria*, *Cladosporium*, or *Dematium pullulans*. Pure cultures were obtained by following Keitt's method of single-spore isolation (1), and these were grown on various solid culture media, including 2 per cent dextrose potato agar, Difco cornmeal agar, and Difco prune agar. Macroscopically, these cultures appeared to be identical. When examined microscopically, however, two

distinct types were recognized, chiefly on the basis of spore size. A representative culture of each type was saved for further study.

On 2 per cent dextrose potato agar, the colonies develop quite rapidly, attaining a diameter of 75 millimeters in eight days, when grown at 25° C. At first they are a deep olive in color, which gradually changes to an olivaceous black. They are very dense from the first, and the surface assumes a velvety appearance from the copious production of spores.

A culture of *S. graminis* was obtained from the Centraalbureau



FIG. 1. Photomicrograph of *Stemphylium congestum* var. *minor* growing on Difco cornmeal agar. $\times 275$.

voor Schimmelcultures, and *S. congestum* was available for study from the stock cultures at the Washington Experiment Station. These were compared culturally with the two *Stemphylium* forms isolated by the writer. Of these two, the one having the larger

spores was found to agree in all respects with *S. congestum*. It is believed, however, that Newton did not see all the spore types produced by this species. On certain kinds of culture media, especially the 2 per cent dextrose potato agar and Czapek's

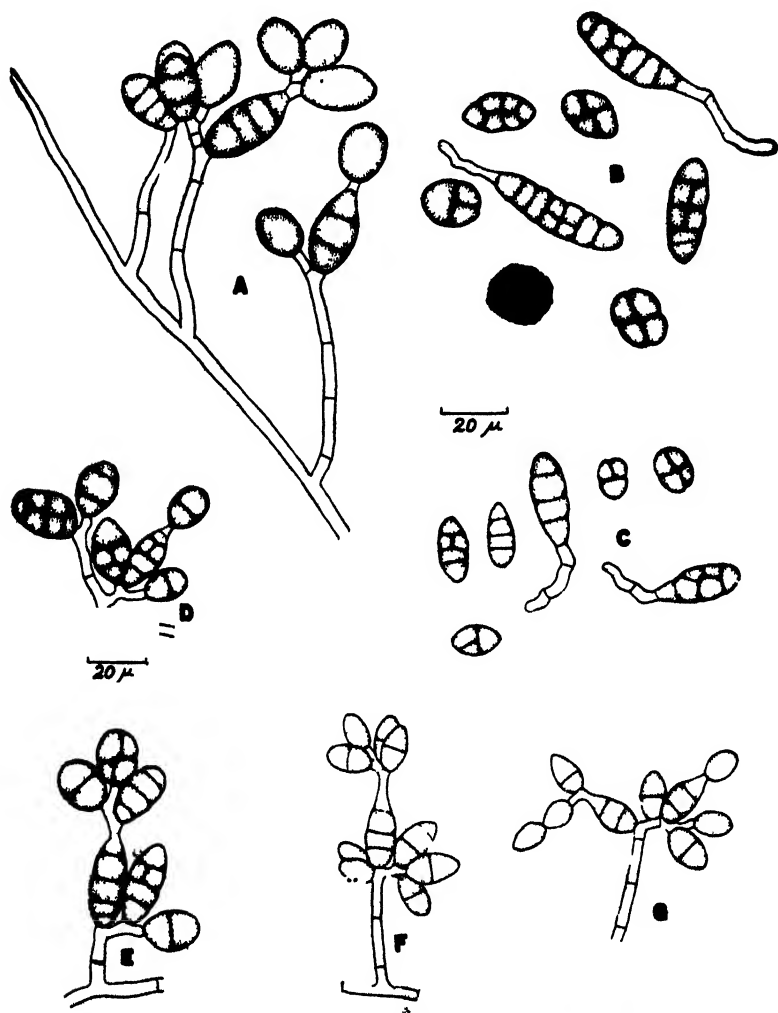


FIG. 2. *Stemphylium* forms from the apple. A, *S. congestum* on Czapek's medium; B, mature spores of *S. congestum*; C, mature spores of *S. congestum* var. *minor*; D and E, *S. congestum* on dextrose potato agar; F and G, *S. congestum* var. *minor* on dextrose potato agar. All drawings made with the aid of the camera lucida. D and E drawn to the scale indicated on the left; the remainder to the scale indicated on the right.

modified synthetic medium, both in the stock cultures of the Experiment Station and in the cultures isolated by the writer, many of the conidia are borne in short chains, with the basal spore in the chain obclavate in shape and resembling an *Alternaria* spore (FIG. 2, *E*). The botryose clusters of sphaero-quadrilateral conidia figured and described by Newton are always present as well, and this type of spore formation is the dominant one for the species. When the *Alternaria*-like spores were first found, they were thought to be the result of a contamination with *Alternaria*, but when single spores of this type were grown, the resulting colonies produced both types of spores in the same manner as the original cultures of the fungus.

The formation of some of the spores in short chains is also a constant characteristic of the smaller-spored type. (FIG. 1 AND FIG. 2, *F*.) This form agrees in all essentials with *S. congestum*, except in the matter of spore size. The conidia of the latter average 26×15.5 microns, while the spores of the former average but 16.5×10.6 microns. The small-spored type is, therefore, considered to be a variety of *S. congestum* Newton.

On culture media, *S. graminis* appears to be quite distinct from the forms isolated by the writer. The colonies are darker in color, beginning as a grayish-brown rather than olive, and develop somewhat slower. The conidia are rarely produced in chains, and when such chains are found, they consist of but two spores. The long pluri-septate conidia of the *Alternaria* type were not observed in this species.

STEMPHYLIUM CONGESTUM

In Newton's description of this species, the following characteristics for the fungus are given (4):

"Hyphae variously branched, septate, dark, making a dense growth on various media with very copious production of conidia; conidia muriform, sphaero-quadrilateral to ovate-oblong, 1 to 3 transverse septa, 1 longitudinal septum or none, smooth when young, but tuberculate with age, and becoming nearly black, $17-30 \times 12-19$ microns, average 23.5×15.5 microns; conidia produced aërogenously on simple or slightly branched septate conidiophores, never single but accumulating in botryose clusters of two to many."

As a result of the cultural studies of the species by the writer, this description should be emended as follows:

Hyphae variously branched, septate, at first hyaline, then becoming light brown and finally dark brown, making a dense growth on various media with very copious production of conidia: conidia muriform, mostly sphaero-quadrilateral to ovate-oblong, one to three transverse septa, one longitudinal septum or none, many obclavate, frequently beaked, with three to six cross septa, one or two longitudinal septa or none, frequently constricted at the septa; conidia smooth and lightly colored at first, but usually tuberculate with age and becoming nearly black, $17-40 \times 9-24$ microns, average 26.5×15.5 microns; conidia produced acrogenously on simple or slightly branched, septate, light brown conidiophores, accumulating in botryose clusters of two to many, or in short chains of two to three, frequently the basal spore of the chains *Alternaria*-like and forming a cluster of smaller spores on a short beak.

Stemphylium congestum Newton var. **minor** nov. var.

As in the species with the following exceptions: Conidia mostly ovate-oblong to obclavate, some sphaero-quadrilateral, one to four transverse septa, one or longitudinal septa or none, usually constricted at the septa; conidia smooth, lightly colored at first, becoming dark brown, $12-31 \times 7-13$ microns, average 16.5×10.6 microns.

Isolated from dark brown lesions on Jonathan apples, and by means of inoculation experiments found capable of producing such lesions on ripe apples. Of less frequent occurrence than the species.

Inoculation experiments were carried out with both *S. congestum* and the variety, on ripe Jonathan and Rome Beauty apples, at 25°C ., $15-25^{\circ}\text{C}$., and 0°C ., using the method recently described by Huber (5). At the higher temperatures, rot lesions formed rather slowly when inoculations were made by placing spores in fresh punctures. At 25°C ., *S. congestum* produced rotted areas up to 55 millimeters in diameter after a 60-day incubation period. At $15-20^{\circ}\text{C}$., lesions 20-30 millimeters in diameter were produced in the same length of time. At 0°C ., rotting

was very feeble, since after four months' incubation at this temperature the largest lesions produced were slightly less than 15 millimeters in diameter. The variety produced decay at about the same rate as the species.

The rotted areas produced by *Stemphylium* are quite firm, light to dark brown in color, and are slightly wrinkled and sunken on the surface. Numerous spores may be produced in the rotted tissues, but none appear on the surface of the lesions. The mycelium of the fungus is both inter- and intra-cellular.

Stemphylium is of little importance on apples when they are held at cold-storage temperatures. Under common storage conditions, however, the rot may be of considerable importance on ripe apples. Lesions produced by *Stemphylium* may readily be mistaken for lesions produced by several species or strains of *Alternaria*, and no doubt a large percentage of decay in the Pacific Northwest attributed to *Alternaria* spp. is due to *S. congestum*.

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FOMES EVERHARTII ASSOCIATED WITH THE PRODUCTION OF STERILE RIMOSE BODIES ON FAGUS GRANDIFOLIA

RAY R. HIRT

(WITH PLATE 25)

Sterile rimose conks are often found on beech and birch and their production is commonly associated with *Fomes igniarius* Gill. It is not unusual to find normal fruiting bodies of this fungus and sterile rimose bodies on the same host. The decay accompanying such sterile bodies is typical of the white heartrot produced by *Fomes igniarius*.

On August 20, 1929, a beech (*Fagus grandifolia* Ehrh.) was observed which had upon it a large number of sterile rimose conks. This tree was approximately 75 years of age and was growing in the Pack Demonstration Forest at Warrensburg, New York. The sterile bodies were similar in appearance to those supposedly produced by *Fomes igniarius*. From one of the larger sterile conks a normal sporophore had developed and at the time it was casting spores in abundance. Upon examination it was discovered that the fruiting body was not that of *Fomes igniarius*, but was typical of *Fomes Everhartii* Ellis & Gall. This identification was later verified by Dr. L. O. Overholts.

The rot produced in the host was similar to that produced by *Fomes igniarius* except, possibly, that there were fewer black lines of decay than are generally found in the white heartrot associated with that fungus.

Fomes Everhartii Ellis & Gall. is not common in the Adirondacks and, so far as the author is aware, has never before been reported as associated with the production of sterile rimose conks on beech.

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FOMES EVERHARTII

EXPLANATION OF PLATE 25

Figures 1 and 2. Two views of a sporophore of *Fomes Everhartii* which show it to be growing directly out of a sterile rimose conk. $\times 1/7$; Figure 3. One of the larger, well developed sterile bodies. $\times 5/12$; Figure 4. A younger sterile body than that shown in Figure 3. $\times 3/8$; Figure 5. A cross section of the decayed trunk of the host to show the general appearance of the rot. $\times 3/10$.

THE STRUCTURE OF THE PERITHECIUM IN THE MELIOLINEAE

MILDRED E. RAGLE

The Meliolineae comprises a homogeneous group but shows relationships with several groups of fungi. Its members are remarkably constant as to spore character but to a less degree regarding the structure of the perithecium.

The Meliolineae show relationship with the Microthyriaceae through *Amazonia*. The original description of *Amazonia* places it as a section of the Microthyriaceae. von Höhnelt has shown that in this genus, under the shield-like cover, a completely closed perithecium exists, pale and thin walled, and properly regards this as a transition genus between *Meliola* and the Microthyriaceae. Superficially there is a striking resemblance between *Amazonia* and *Asterina*. Both possess hyphopodiate mycelium, and the perithecium in each case is rounded above. However, *Asterina* has a large stellate ostiole and the perithecium is flattened, while the ostiole in the Meliolineae, when present, is small and circular, and the perithecium varies from dimidiate to globose, but is never flat.

The relationship of the Meliolineae with the Dothideales is shown through the genus *Actinodothis*. However, as a rule, the Dothideales are partially, if not entirely, immersed in the substratum, while *Actinodothis* is entirely superficial with the exception of a few minute strands which anchor the perithecium to the substratum. The asci in *Actinodothis* are evanescent, disappearing soon after the spores are mature. This is a constant characteristic of the Meliolineae.

The Meliolineae in itself is a homogeneous group. The spores show very little variation in size and shape.

To determine whether the closely related genera showed any constant differences in perithecial structure, microtome sections of numerous species were studied using one or more species of each genus and, in the case of *Meliola*, one member of each subgroup. The following species were examined.

Actinodothis Perrottetiae; *Amazonia Perrottetiae*; *Amazonia anacardiacearum*; *Amazonia Acalyphae*; *Amazonia qhianus*; *Amazonia asterinoides*; *Amazonia Clusiae*; *Irene tonkinensis*; *Irene inermis*; *Irenopsis scaevolicola*; *Irenina longipoda*; *Meliolina Sydowiana*; *Meliola nidulans*, group 1; *Meliola contorta*, group 2; *Meliola Piperis*, group 3; *Meliola Paullinae*, group 4; *Meliola bicornis*, group 4; *Meliola variaseta*, group 5; *Meliola Wardii*, group 6; *Meliola Sideroxili*, group 7; *Meliola malacotricha*, group 8; *Meliola Lisanthi*, group 9; *Meliola Byrsonimae*, group 10; *Meliola Psidii*, group 11.

This investigation showed that in all cases the perithecium is composed of two types of cells. The outer part consists of large, biscuit-shaped to oblong cells with heavy cell walls. These cells are always colored, ranging from brown to black, being in all cases the same color as the mycelium. The cells are remarkably uniform in size throughout the group, ranging from 7 to 10 microns in diameter regardless of the size of the perithecium on which they are found. In the genus *Meliola*, the outer cells are one row thick. One exception was observed in which, however, only two or three places were observed in one perithecium where there were double rows. In *Amazonia*, the cells are arranged in two or three to many rows. *Actinodothis* shows many rows of cells, the outermost being arranged to form a stroma. In *Irene*, *Irenina* and *Irenopsis*, this tissue is one cell thick.

The inner layer is more delicate and lighter colored. It forms a smooth lining for the perithecium and is even more constant in character for the group than is the outer layer. In *Actinodothis*, which has the typically dimidiate perithecium, this layer is the only one between the asci and the substratum. A similar condition is found in *Meliola malacotricha* and *Irenopsis scaevolicola*. In some cases a differential staining was obtained in the two layers; the outer one invariably showing a reaction similar to that of the mature spores and the lignified tissues of the host with Pianeze III B, while the inner one often took a stain similar to the young spores and the contents of the perithecium. The cells of this layer are long and narrow with tapering end walls. In size, they are approximately 1.5 to 3 by 8 microns. This layer is usually one cell thick, the only exception being in *Amazonia*, where it is found to be two cells thick in some species.

Externally, the shape of the perithecium varies from the dimidiate, elongate, dothid-like structure found in *Actinodothis*, through the typically dimidiate forms in *Amazonia* (of which the highest, *A. asterinoides*, at maturity shows a globose perithecium) to the spherical perithecium of *Meliola*.

In the genera of the Meliolineae, a well defined base may be absent as in *Actinodothis Perrottetiae*, *Irenopsis scaevolicola* and *Meliola malacotricha*, where the inner layer of the perithecium rests directly on the substratum, or it may be represented by the outer layer of the perithecium as in *Meliola bicornis* and *Meliola nidulans*. The base is generally present in *Amazonia*, *Irene*, and some of the species of *Meliola*, where it is represented by a mass of mycelium, or a stalk of cells resembling those in the outer layer of the perithecium, or by a flat disk from which setae radiate. In *Meliolina*, the base takes the form of a slender stipe.

There is variation in the surface cells in the outer layer of the perithecial wall. In *Meliola nidulans* the surface is even, while in *Meliola Psidii* the cells show a very few irregularities. *Meliola bicornis*, *Meliola contorta*, and *Meliola Wardii* show a distinct wartiness. Warty protuberances present the most common type of surface structure in the group. These may be so prominent as to become vermiform appendages, as found in *Irene*, or still longer, as the perithecial setae of *Irenopsis*, where they are most common. Perithecial setae have been reported on *Meliola contorta*, but none were found in the material examined. Perithecial setae are never found in *Irenina*.

An ostiole may or may not be present. When it is present, it is usually small but well defined. The cells of the perithecium form a short crown-like beak, which surrounds the opening. In some species, the inner layer of the perithecium extends up into the ostiole and forms a lining for it. In the majority of the species observed, in which the ostiole was present, the crown-like beak was a continuous layer of the perithecium.

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SEPTATION OF THE ASCUS IN DOTHIDINA

RHODA B. CROUCH

A peculiar condition of septation of the ascus of *Dothidina costaricensis* Stevens was reported by F. L. Stevens in 1927.¹ This septation occurs either longitudinally or transversely. The phenomenon of septation of the ascus is very rare, occurring, so far as is known, in only a few other fungi which are widely separated taxonomically. The condition has been reported in the genera *Othiella*,¹ *Ascobolus*,² *Sphaerophoron*,³ *Acroscyphus*,³ *Lichina*³ and *Paulia*.³ According to the usual way in which spores are delimited from the ascoplasm following the ordinary mitotic division this phenomenon seems to be unexplainable.

With the hope of throwing further light upon this condition sections of *Dothidina costaricensis* Stevens were cut ten microns thick, stained with Pianese III B. The perithecia were also cracked open, the asci mounted in water; septation was found to be present in practically all the asci. The young, immature asci were septate as well as the mature asci. A few asci showed no septation but this was probably due to mechanical crushing. This study did not point out how these septations arose, for in the asci examined the septation was complete when examined; however it did seem to be due to an extension of the cell wall between the spores giving rise to chambers, each of which contained one spore or on rare occasions two.

A thorough examination of all available species of *Dothidina* and related genera was carried out to ascertain whether any of these allied genera exhibited the same phenomenon. This was done by cracking the perithecia open and mounting in water. Following is a list of the genera and species examined:

Bagnisiopsis peribebuyensis (Speg.) Theiss. & Sydow; *Amerodothis guianensis* Stevens; *Auerswaldia chamaeropsis* (Cooke) *Sacc.; *Auerswaldia cecropiae* P. Henn.; *Auerswaldia* species; *Auerswaldia Pringlei* (Peck.) Sacc.; *Dothidina costaricensis* Stevens; *Dothidina palmicola* (Speg.) Theiss. & Sydow; *Dothidina*

scabrosa Sydow; *Dothidina discoformis* (Wint.) Theiss. & Sydow; *Dothidina Fiebrigii* (P. Henn.) Theiss. & Sydow; *Dothidina amadelpha* Sydow; *Uleodothis Pteridis* Stevens; *Uleodothis Paspali* Stevens; *Dothidella flava* Stevens; *Dothidella betulina* (Fries) Sacc.; *Dothidella portoricensis* Stevens; *Systremma Pterocarpi* Doidge; *Achorella guianensis* Stevens; *Achorella costaricensis* Stevens; *Achorella Attaleae* Stevens; *Dothidea graminis* Peck.

In none of the above forms except *Dothidina costaricensis* Stevens was ascus septation found to occur. The origin and function of this septation could not be ascertained due to the absence of living, young material.

Though negative these results appear to be worthy of record.

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A STUDY OF SOME HOMOTHALLIC AND HETEROTHALLIC ASCOMYCETES ¹

LAWRENCE M. AMES

The discovery of homothallism and heterothallism in the Mucorales by Blakeslee (2), in the Eubasidiomycetes by Kniep (8), Mlle. Bensaude (1), and others, in the Rusts by Craigie (3), in the Smuts by Hanna (6), and others, and in the Ascomycetes by Dodge (4), Edgerton (5), etc., has led the writer to undertake further studies in the Ascomycetes.

This paper presents some work that has been done on a few coprophilous Ascomycetes. Single spore cultures were made in all cases and matings in all combinations were employed in the study of the sexuality of these fungi. The cultures were all grown on agar in petri dishes at room temperature. Single spore cultures were obtained by a dry needle method similar to that described by Hanna (7).

It was found helpful in germinating the spores of *Ascobolus* to treat them first with a warm solution of dilute HCl for five or ten minutes and after planting to heat them in an oven to a temperature of 78° C. for an interval of 25 minutes. In the case of *A. immersus* even this treatment failed in all but two cases.

The following table gives in a brief form the origin and conditions under which each organism was grown and the type of fruiting, *i.e.* whether homothallic or heterothallic.

The work of Marchal (9) on *Chaetomium elatum* Kunze & Schm. and *Hypocopra fimicola* Sacc. (*Fimetaria fimicola* (Roberge) Griffiths & Seaver) is substantiated by the present work.

In his study of *Neurospora* Dodge (4) found an interesting phase of spore formation in the species *N. tetrasperma*. The ascus in this species normally contains four spores. If several perithecia are crushed in which spores are maturing there will be found occasional asci with an abnormal number of spores such as three

¹ This paper is a much abbreviated form of a thesis submitted in partial fulfillment of the requirements for the M.S. degree at Michigan State College.

Name of Organism	Origin	Culture Media	Spores per Ascus	Condition of Sexuality
<i>Chaetomium spireale</i> Zopf. ¹	Straw	P. d. agar ⁴	8	Homothallic
<i>C. globosum</i> Kunze ²	Straw	P. d. agar	8	Homothallic
<i>C. elatum</i> Kunze & Schmidt	Straw	P. d. agar	8	Homothallic
<i>C. fasciculale</i> Cooke	Straw	P. d. agar	8	Homothallic
<i>C. swarzum</i> Chivers ³	Rice hulls	P. d. agar	8	Homothallic
<i>C. trilaterale</i> Chivers ⁴	Blueberry roots	P. d. agar	8	Homothallic
<i>C. cockitodes</i> Pallister	Straw	P. d. agar	8	Homothallic
<i>C. angustum</i> Chivers	Straw	P. d. agar	8	Homothallic
<i>C. alerrimum</i> Ellis & Ev.	Straw	P. d. agar	8	Homothallic
<i>C. murorum</i> Corda	Horse dung	Dung agar	8	Homothallic
<i>Findaria finicale</i> (Roberge) Griff. & Seaver	Horse dung	Dung agar	8	Homothallic
<i>Pleuroge erismensis</i> D. Griff.	Horse dung	Dung agar	4	Homothallic
<i>P. anomala</i> D. Griff.	Horse dung	Dung agar	4	Homothallic
<i>P. aserina</i> (Ces.) Kuntze	Horse dung	Dung agar	4	Homothallic
<i>P. decipiens</i> (Wint.) Kuntze	Horse dung	Dung agar	8	Homothallic
<i>P. minus</i> (Fuekel) Kuntze	Horse dung	Dung agar	8	Homothallic
<i>Ascobolus stercorarius</i> (Bull.) Schröt. ⁴	Horse dung	Dung agar	8	Hetero-homothallic

¹ Three additional unidentified species of *Chaetomium* were found to be homothallic.

² This species was given to me by Mr. F. C. Strong of Michigan State College, who found it on some straw which came from Maryland.

³ *Chaetomium swarzum* was sent to me by Dr. Edgar C. Tullis of the University of Arkansas.

⁴ Mr. Stanley Johnston of South Haven, Michigan, kindly sent this fungus.

⁵ *Ascobolus immeris* gave no results as to its sexuality, but brought to light an interesting food requirement necessary for its culture.

⁶ P. d. agar—potato dextrose agar.

large and two small spores, or even in extreme cases only one giant spore. Shear and Dodge (11) found that monosporous mycelia from these small spores bore only sclerotia or bodies which resembled aborted perithecia. By properly mating these cultures normal perithecia are formed containing asci which normally have only four spores. The larger normal spores have two nuclei when first delimited and thus contain nuclei of both sexes. In *N. sitophila*, which has eight ascospores, four of these spores variously arranged in the ascus are of one sex and the other four of the other sex, this species being invariably heterothallic. One might conceive from the above data that in a genus which contains both four- and eight-spored species he would find them to be homothallic and heterothallic respectively.

In the present work it was found that both the four- and eight-spored species of the genus *Pleuraea* were homothallic. It is therefore clear that in a genus in which the number of spores varies with the species no prediction can be made that one of the species will be homothallic and the other heterothallic.

In the genus *Glomerella*, Edgerton (5) found a condition which approaches heterothallism. The peculiar trait of producing abundant perithecia at one time and a scarcity at another time in nature gave grounds for presupposing sexual differentiation. Single spore isolations yielded two strains, a "plus" strain of floccose growth and abundant aërial mycelium, and a "minus" strain with scarcely any aërial mycelium. However, single spore cultures of each strain produced abundant perithecia. When both strains were grown on one agar plate there appeared a great mass of perithecia along the line where the mycelia of the two colonies met. To determine whether this was truly sexual stimulation or due to chemical and food relations, some of the perithecia along the border were crushed and separate asci were removed and planted individually on agar plates. Edgerton found that segregation took place giving the two characteristic strains. This segregation of strains gives proof that there was sexual stimulation and therefore sexual differentiation.

A similar condition was found in the present work with *Ascobolus stercorarius*. Single spore cultures of this species gave rise to a few apothecia. By mating single spore cultures it was

found that approximately fifty per cent of the matings stimulated a great abundance of apothecia along the line where the mycelia of the two strains met. This shows that whereas single spore cultures may produce a few apothecia there is, however, a definite sexual differentiation. It is yet to be discovered whether the antherids are functional in all cases or whether parthenogamy may occur to explain the production of the occasional apothecia on single spore cultures.

Difficulty was encountered in germinating the spores of *Asco-bolus immersus*, and the two spores which grew produced very weak mycelia and no fruit bodies. This difficulty was also met by Ramlow (10) who found that *A. immersus* would not grow or produced only a weak mycelium and almost never the fruit bodies on dung agar alone, but after adding a portion of filter paper to the media he found that the fungus grew and fruited well. In his studies of *A. immersus* both morphologically and cytologically, he demonstrated that this species is parthenogamic (*i.e.* there is no distinct antherid and the paired nuclei in the ascogonial cells and ascogenous hyphae are all of ascogonial origin). Such a species would necessarily be homothallic unless antherids are formed when two sexes of mycelium are present, and no antherids if only one is present.

A number of other Ascomycetes were also studied, one of which proved to be strictly heterothallic, but owing to uncertainty as to their identity they cannot be reported on at present.

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NOTES AND BRIEF ARTICLES

Dr. C. S. Parker of Howard University, Washington, D. C., recently spent a few days at The New York Botanical Garden looking over collections of fungi.

The Editor is finding much difficulty in taking care of the manuscript which is sent in for publication in MYCOLOGIA. In order to save space contributors are hereby requested to cut down their papers as short as possible. This with the increased pagination in MYCOLOGIA will help us to solve the difficulty.

Mr. Paul F. Shope, Mycologist in the University of Colorado at Boulder, spent a few days in September at The New York Botanical Garden looking over Colorado polypores. Mr. Shope is on leave of absence from the University of Colorado and will spend the year in graduate study at the Missouri Botanical Garden, St. Louis, Missouri.

A second edition of "Fungous Diseases of Plants in Agriculture, Horticulture, and Forestry" by Dr. Jakob Eriksson of Stockholm, Sweden, translated from the German by Dr. William Goodwin of London was issued during 1930. The work consists of 526 pages of text and is illustrated with 399 figures, and consists of a review of the principal fungous diseases of northern and middle Europe with the best known methods of control. The book, which is published by Bailliere, Tindall & Cox of London, is attractively printed and illustrated and should find its way into the library of every plant pathologist.

Mycologists and Plant Pathologists will be pleased to see the volume on "The Lower Fungi" by Harry Morton Fitzpatrick, Professor of Mycology, Department of Plant Pathology, Cornell University, Ithaca, New York, which was recently issued. In

this work. Dr. Fitzpatrick has given a general treatment of the morphology of the Phycomycetes with keys to the recognized genera. The volume consists of 331 pages illustrated with 112 text figures mostly line drawings bringing out the striking characters of the various genera. The book is published by McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. The price is \$4.00. It is expected that a more extended review of this book may appear later in MYCOLOGIA.

"The Spore Ornamentation of the Russulas" by Richard Crawshaw has just been issued, the work having been published by Bailliere, Tindall & Cox of London, England. Too little attention has been given to spore ornamentation as a means of identifying species in the Basidiomycetes, probably much less than in the Ascomycetes. Perhaps this is because there is less variety in spore-sculpturing in the Basidiomycetes. Mr. Crawshaw has made a thorough study of this character in the genus *Russula*. In all seventy species and twenty-two varieties are treated. The spores of eighty-five of these are represented by drawings. The book consists of 179 pages of text and 46 plates. The plates contain the drawings of the spores of the various species of the genus made to a common scale. This excellent work should be exceedingly helpful to those interested in the study of this genus, and an incentive to mycologists to make a similar study of other genera.

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